A RETROSPECTIVE STUDY COMPARING THE COSTS AND OUTCOMES OF THREE ALTERNATIVES FOR MONITORING PATIENTS WHO COME TO AN EMERGENCY DEPARTMENT WITH CHEST PAIN (ICD-9 CODE 78650 & 78659)

A

THESIS

Presented to the Faculty of

The University of Texas Graduate School of Biomedical Sciences

at San Antonio

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

By

Joyce K. Borgfeld, B.S.N.

San Antonio, Texas

May 2000

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	9.May.00	THESIS

4. TITLE AND SUBTITLE
A RETROSPECTIVE STUDY COMPARING THE COSTS AND OUTCOMES OF THREE ALTERNATIVES FOR MONITORING PATIENTS WHO COME TO AN EMERGENCY DEARTMENT WITH CHEST PAIN (ICD-9 CODE 78650&78659)

5. FUNDING NUMBERS

6. AUTHOR(S)
MAJ BORGFELD JOYCE K

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
UNIVERSITY OF TEXAS HSC SAN ANTONIO

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
THE DEPARTMENT OF THE AIR FORCE
AFIT/CIA, BLDG 125
2950 P STREET
WPAFB OH 45433

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FY00-188

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Unlimited distribution
In Accordance With AFI 35-205/AFIT Sup 1

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

14. SUBJECT TERMS			15. NUMBER OF PAGES
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

A RETROSPECTIVE STUDY COMPARING THE COSTS AND OUTCOMES OF THREE ALTERNATIVES FOR MONITORING PATIENTS WHO COME TO AN EMERGENCY DEPARTMENT WITH CHEST PAIN (ICD-9 CODE 78650 & 78659)

Joyce K. Borgfeld

APPROVED:

_____
Supervising Professor

_____

_____

_____

_____
Date

APPROVED:

_____
Sanford A. Miller
Dean

DEDICATION

This work is dedicated to my husband, Mark, and my mother Joyce. They were my cheerleaders, my support, and my strength. I couldn't have done it without them.

ACKNOWLEDGEMENTS

I'd like to take this opportunity to thank everyone that helped me accomplish my goal. To Mrs. Seretha Fondren, and the staff of the inpatient medical records section who pulled the inpatient and observation records I needed for data collection. To SSgt Johnson and the outpatient records staff, who allowed me to invade their workspace so that I could pull outpatient records for my data collection. To MSgt Caudill in the laboratory, who obtained a listing of the cardiac enzyme tests conducted during the 6-month data collection period, as well as the results. To the nurse managers and assistant nurse managers of the three monitoring sites: Major Naworal, Major Bryant, and Captain Olsson, who allowed me to review the nursing staff duty schedules. To Millie Modzelesky, in the Business Operations Office, who provided me with the nursing staff salary costs. To Shirley Zoblosky, in the Coding Office, who provided me with the ICD-9 and CPT-4 codes for discharge diagnoses, laboratory tests, and procedures relevant to my study. To Bobby Elizondo, in the Decision Support Office, who helped me retrieve data from the various computer databases at the study site.

I would also like to thank Major Elizabeth Bridges and Mr. Joe Fischer, in the Research Department at the study site, for their unflagging support of this project. My thanks to Major Bridges who helped me navigate the exempt protocol review process, and to both of them as they helped me analyze my data, analyze my data, and analyze my data!

I am grateful to the members of my committee: Drs. Elaine Graveley, Nancy Girard, and Susan Hall, for their tireless assistance throughout the entire research process. Their expertise and knowledge helped to make this a rewarding experience. They helped me to see research in a whole new light.

Finally, I would like to thank my supervising professor, Dr. Elaine Graveley. Words are not really adequate to express my appreciation for her guidance and support. She challenged and encouraged me every step of the way.

A RETROSPECTIVE STUDY COMPARING THE COSTS AND OUTCOMES OF THREE ALTERNATIVES FOR MONITORING PATIENTS WHO COME TO AN EMERGENCY DEPARTMENT WITH CHEST PAIN (ICD-9 CODE 78650 & 78659)

Publication No. _____

Joyce K. Borgfeld, B.S.N.

The University of Texas Graduate School of Biomedical Sciences

At San Antonio

Supervising Professor: Elaine Graveley

The purpose of this study was to explore the costs and outcomes of monitoring patients with chest pain in three alternative care sites in a military medical treatment facility (MTF) using the Reynolds and Gaspari framework. The three alternative care sites within the military MTF included: (a) The emergency department, (b) the outpatient observation unit, and (c) the inpatient cardiology unit. Costs were measured on the basis of nursing personnel salaries,

diagnostic testing costs, consultant costs, and length of stay. The outcome variables included: (a) Percent of monitored patients diagnosed with an MI on each unit, (b) percent of monitored patients on each unit who returned with a complaint of chest pain within 30 days of release, (c) length of stay for patients with chest pain on each unit, (d) the type and number of diagnostic tests ordered to rule-out MI by physician specialty on each unit, (e) length of stay for patients enrolled in TRICARE (military health maintenance organization) and not enrolled in TRICARE, and (f) differences in demographic characteristics and number of co-morbidities in patients diagnosed with MI and patients ruled-out for MI on each unit. The population studied was primarily Caucasian (73%) and there were a greater percentage of males (54%) in the study sample of 167 patients. Cost and outcome data were collected retrospectively from hospital computer databases, and patient's hospital and outpatient records. There were significant differences in length of stay and costs among the three alternative monitoring sites. The ED had the highest nursing salary costs, but the lowest overall costs. The ED also had the shortest length of stay (M=197 min [3 hrs 17 min]). The outpatient observation unit had significantly lower costs than the inpatient cardiology unit with no significant differences in patient outcomes. Only 1.2% (N=2) of the patients in the study were diagnosed with an MI, and only 2.6% (N=1) of the patients who returned within 30 days with complaints of chest pain were diagnosed with an MI. There were significant differences in the number of diagnostic tests among the monitoring sites, and in the number and type of diagnostic tests between the outpatient observation unit and the inpatient cardiology unit. There were also significant differences in the number of co-morbidities among the monitoring sites. There were significant differences in gender among the monitoring sites, with the ED treating and releasing a greater percentage of female patients than the outpatient observation or inpatient cardiology units. There were, however, no significant differences in the risk factors for MI ("heart risk" co-morbidities, and overweight and obese body mass index [BMI]) between male and female patients in the ED. There were no significant differences in length of stay and TRICARE enrollment status, but there was a trend toward

longer length of stay for patients not eligible for enrollment in TRICARE in all three monitoring sites. This study provided evidence that, for the extended evaluation of patients with chest pain, the outpatient observation unit had significantly lower costs and similar patient outcomes when compared to the inpatient cardiology unit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

Overview and Significance

Health care spending continues to increase at a pace well above the general inflation rate with "not only more money ...but also a much larger share of all money earned spent on health care" (Finkler & Kovner, 1993, pp. 19, 22). In a free market economy, such as the United States, supply and demand generally determine price (Finkler & Kovner). In such an economy, the relationship between the supplier and the consumer is a circular one; consumers work for a supplier in the market and are paid by them for their services and the supplier makes products or provides services and sets the market price. The consumer buying the product or service completes the market cycle (Finkler & Kovner).

The consumer decides whether or not to purchase a product at the market price. Generally in a free market economy, a high price for a product or service lowers consumer demand, while a lower price generally increases demand. Product or service demand is influenced by consumer preference, ability to pay, and availability of substitutes (Finkler & Kovner, 1993). The ability to pay is determined by the amount of consumer disposable income while product availability is driven by consumer demand. When demand for a product or service is high, new suppliers introduce product or service substitutes into the market increasing competition (Finkler & Kovner). It is the consumer who determines whether the product/service substitute is acceptable (Finkler & Kovner). In addition, when a product becomes too expensive the consumer looks for substitutes. Competition generally lowers the product/service price and may even force some suppliers out of the market if they are unable to make a profit at the lower price (Finkler & Kovner).

The health care market does not reflect the previously discussed paradigm of the free market exchange system. First, the demand for health care is not significantly affected by a large change in price; it is considered an almost inelastic service (Finkler & Kovner, 1993). For

example, a consumer who needs surgery or is having a myocardial infarction needs care no matter what the cost or whether the consumer has sufficient disposable income to pay for the service.

Second, until very recently, the availability of substitutes has been limited. Although research shows that nurse practitioners have been used in private medical practices since the1960s (Sox, 1979) their presence in the market has not been a significant factor until very recently (Buppert, 1998).

Third, the health care system operated and continues to operate outside the previously described free market system. Within the health care system, the insurance companies and the government act as intermediaries by paying for many individual's cost of care. Until recently, neither the consumer, the physician, or the healthcare agency provider was concerned with cost; a third party was paying the bill. Charges were based upon what the market would reimburse, and with the government and insurance companies willingly paying the bill, health care provider and agency charges escalated exponentially.

Government involvement as a payer for health care services began in 1965 with the creation of the Medicare Program, administered by the Healthcare Financing Administration (HCFA) (Finkler & Kovner, 1993). Medicare is a federal insurance program for the elderly and permanently disabled. Prior to 1983, Medicare reimbursed hospitals for inpatient care based on what the hospital determined the costs incurred for that care (Finkler & Kovner). This is known as cost-based reimbursement (Finkler & Kovner). In the early 1980's, with health care costs out of control and their inflation rate reaching 12% the government devised a hospital reimbursement system based upon the amount of care required, medical diagnosis, and length of stay (Finkler & Kovner). In an effort to control costs, the new system would pay the provider a flat rate for a particular diagnosis, which became known as the Diagnosis Related Groups (DRGs). In 1983, Congress authorized HCFA to implement the DRG prospective payment system (Finkler & Kovner). Medicare now reimburses hospitals for inpatient care at a

predetermined rate based on DRG type regardless of the costs incurred and insurance companies are requiring pre-certification for any admission and surgery (Finkler & Kovner).

Since the insurance companies and government remain the primary payers, the consumer never directly influences the purchase price of the health care product. With someone else assuming most health care costs, neither the provider nor the consumer needs to know or become concerned about the costs or how much of the service they utilize (spend). Thus, increasing involvement of government and insurance intermediaries in the payment for health care has increased the demand for care and has resulted in an ever-increasing percent of the Gross Domestic Product (GDP) spent on health care. Americans currently spend $1.1 trillion dollars on health care with costs rising at twice the rate of income and health spending "projected to double again to $2.1 trillion by 2007" (National Coalition for Health Care, 1999). The National Coalition for Health Care (NCHC) also found that the federal government is the single largest payer for health care services, paying 47% of all health care expenditures.

As health care costs continue to escalate, albeit at a slower rate, so the government and insurance companies continue to enact rules to curb health care expenses. One of the areas being scrutinized is the use of expensive inpatient facilities. Prospective payment reimbursement guidelines now include medical necessity and appropriateness guidelines for inpatient admissions (HCFA, 1989). Each potential inpatient admission requires consideration of the patient's need for hospital care for 24 hours or more to include: severity of illness, predictability of adverse outcomes, diagnostic testing required, and availability of diagnostic procedures (HCFA). Patients with symptoms that do not meet medical necessity guidelines for inpatient admission must be treated as outpatients (HCFA).

With the institution of medical necessity and appropriateness guidelines it immediately became evident that patients presenting with symptoms, such as chest pain, might not require immediate inpatient admission. However, in sending these patients home there was an inherent risk of poor outcomes, malpractice suits, and criticisms of the hospitals' quality of care (Graff,

1993). Conversely agencies that chose to admit patients with chest pain to inpatient units risked reimbursement denials for inappropriate admission (Graff). The extensiveness of the monitoring needed by patients with chest pain prohibit adequate care in the typical outpatient environment of either a clinic or private physician practice (Graff).

The dilemma of how to care for patients presenting with chest pain in an emergency department (ED) who require observation without admitting them to an inpatient unit led to the creation of alternative delivery models. One model was the introduction of patient observation areas in the ED. The other model introduced "outpatient" observation units (Graff, 1993). An outpatient observation unit would be capable of providing extended outpatient services, up to 24 hours, for patients not meeting Medicare inpatient admission criteria (Graff).

Observation units are intended to "improve the quality of medical care for patients through extended evaluation and treatment while reducing inappropriate admissions and health care costs" (Brillman et al., 1995, p. 824). Health care literature describes patients on observation units as outpatients because they are never formally admitted to the hospital (Graff, 1993). Graff relates that health care costs are reduced because hospitals avoid Medicare reimbursement denials by billing observation as outpatient care. In addition the professional nursing staff requirement on an observation unit is less than an inpatient unit, also decreasing costs (Graff). Graff notes that "observation services are a rational solution [for providing] high-quality patient care in the present cost-efficient environment" (p. 30).

With the introduction of observation units many hospitals had three choices for monitoring patients presenting with chest pain. They could, depending upon the options available in their facility, monitor the patient in the ED, monitor the patient in an outpatient observation unit or monitor the patient on an inpatient cardiology unit. With the increasing financial pressures facing hospitals it becomes necessary to determine which alternative of care is most cost-effective.

In this chapter, the purpose of the study and the importance of analyzing the costs, patient care outcomes and physician diagnostic practices in alternative patient care delivery models are presented. Following this discussion the theoretical framework, definition of terms, and assumptions and limitations of the study are described.

Purpose

The purpose of this study is to compare the costs, length of stay, patient outcomes and physician diagnostic practices for three alternatives of monitoring patients who come to an emergency department complaining of chest pain (ICD-9 codes 78650 & 78659) in a military medical treatment facility (MTF). In addition, this study will compare TRICARE (military health maintenance organization) enrollment versus non-enrollment status on length of stay, and demographic and co-morbidity differences in patients diagnosed with myocardial infarction (MI) and ruled-out for MI in these three alternatives for monitoring patients with chest pain.

Research Questions

The questions for this descriptive study are, for patients monitored for chest pain in the ED, outpatient observation unit, and inpatient cardiology unit:

1. What are the differences in length of stay?
2. What are the differences in costs for nursing staff, diagnostic testing, consultant and length of stay?
3. What is the difference in percent of patients who present with chest pain and who are ultimately diagnosed with a myocardial infarction?
4. What are the differences in the recidivism rate for returning to the MTF within 30 days with the complaint of chest pain?
5. What are the differences in physician specialty and the type and number of diagnostic tests ordered to rule-out MI in patients?
6. What are the differences in length of stay for patients enrolled in TRICARE and not enrolled in TRICARE?

7. What are the differences in the demographic characteristics and co-morbidities of patients diagnosed with MI and patients ruled-out for MI?

Theoretical Framework

A variety of economic analyses are conducted within the health care environment in an attempt to answer the question "What does it cost?" (Silverstein & Ward, 1999). The types of analyses are cost, cost-effectiveness, cost utility, and cost-benefit. This study will be a retrospective descriptive cost study that analyzes the resources used to care for patients with chest pain in three alternative delivery sites and the outcomes of care. It will be conducted from the viewpoint of the provider of health care. The provider of health care is "concerned with [the] costs of providing services" (Silverstein & Ward, p. 2).

A descriptive cost study "identifies the costs of providing a health service...costs are usually expressed per [unit of] service provided, per person [case], or per population" (Silverstein & Ward, 1999). Reynolds and Gaspari (1985) provide a cost analysis framework for use in this study. The major requirements include, "1) defining the operational problem and objectives, 2) identifying alternative solutions to the problem, 3) identifying and measuring the costs of each alternative, 4) analyzing the costs of each alternative, 5) conducting a sensitivity analysis" (Reynolds & Gaspari, p. 21).

Each requirement is further described as follows:

1. Defining the operational problem and objectives. Analysis of the problem begins with "the identification of a discrepancy between *what should be* and *what actually is occurring*" (Reynolds & Gaspari, 1985, p. 21). After defining the research problem, the measurable goal(s) are identified. Identifying the goals is a two-step process that includes determining (a) the outcome variables to use, and (b) how to measure each variable (Reynolds & Gaspari).
2. Identify the alternative solutions to the problem. Defining the problem and research goal(s) assists in determining alternative solutions.

3. Identify and measure the costs of each alternative. Reynolds and Gaspari (1985) note that both recurrent and capital costs must be considered. Recurrent costs are identified as: (a) Personnel salaries, (b) fringe benefits, (c) materials and supplies, (d) consultant fees, (e) travel, and (f) other direct costs. Capital costs include: (a) equipment, (b) buildings, and (c) vehicles. Reynolds and Gaspari note that only the pertinent costs of each alternative should be analyzed. Pertinent costs, they explain, are those costs that differ for each alternative. For example, if alternate training programs have the same costs for facilities, etc., but different costs for personnel and contract services, the latter costs are the pertinent ones to be analyzed (Reynolds & Gaspari).
4. Analyze the costs of each alternative. Reynolds and Gaspari (1985) describe the four cost analysis procedures comparing the: (a) least and most costly alternative, (b) percent distribution of the line items of each alternative, (c) absolute differences in line item costs, and (d) relative differences in line item costs.
5. Conduct a sensitivity analysis. However, a sensitivity analysis is conducted only when estimated costs are used in a study. (Reynolds & Gaspari, 1985).

The Reynolds and Gaspari (1985) cost analysis framework is applied to this study as follows:

1. The operational problem is: In a military acute care medical treatment facility (MTF) what patient care area is the most cost effective to monitor patients who present to the ED with chest pain?
2. The alternative solutions to the problem are monitoring patients with chest pain in the ED, outpatient observation unit, or inpatient cardiology unit.
3. The appropriate costs to include in this study are described as follows:
   A. Recurrent Costs
      1) Salaries and fringe benefits will be included in this study for the personnel involved in patient care at each level of care. Consultant fees will be considered pertinent

costs in this study because a resident physician from the medicine (weekdays) or cardiology (weeknights, weekends, holidays) service must evaluate any patient with chest pain in the ED who requires a stay on the outpatient observation unit or inpatient cardiology unit. Length of stay (LOS) is pertinent to this study because LOS is a predominant factor in cost-savings. As Graff notes, "the amount of savings per patient...depends on shortening the length of stay" (p. 99). Therefore, LOS data for each level of care will be considered in the recurrent costs.

2) Material and supply costs include the diagnostic testing necessary to rule-out MI in patients with chest pain. This testing includes: (a) cardiac enzyme testing, (b) ECG recordings, and (c) telemetry monitoring

The diagnostic testing required to rule-out an MI in a patient with chest pain may vary among the three alternative monitoring sites and are considered pertinent costs for this study. These costs will be obtained for patients monitored in the ED, "outpatient" observation, and inpatient monitoring.

3) Equipment costs include: (a) Resuscitative equipment, (b) ECG machines, (c) telemetry monitoring equipment, and (d) vital sign machines.

Resuscitative equipment is standardized throughout the facility and therefore costs for this equipment will be considered constant. ECG machines, telemetry monitoring equipment, and vital sign machines are considered capital equipment and will be discussed below.

4) Travel costs will not be considered pertinent costs because the personnel at each level of care do not travel from the facility to provide patient care.

5) Maintenance costs will not be considered pertinent costs because they will not vary among the levels of care; all of the treatment areas are located within the same acute care military medical treatment facility (MTF).

B. Capital Costs

1) The three levels of care being studied are all located within the same military MTF built in the 1950's. Multiple renovations have occurred in the past 40 years; these renovations used appropriated government funds and the costs for the renovations are not part of the facility's capital budget. Therefore, in this study these capital costs will not be considered.

2) Electrocardiogram (ECG) machines, telemetry monitoring equipment and vital sign machines are considered capital equipment. There is no data available on the number of patients who use this equipment per year therefore it is impossible to determine a unit of service cost for these items. Therefore, in this study these capital costs will not be considered.

3) Vehicles are not used among the levels of care to transport personnel or patients out of the facility. Therefore, in this study there are no costs related to vehicles to consider.

To summarize, an analysis of the recurrent and capital costs determined that the pertinent recurrent costs for this cost-analysis include: (a) personnel salaries and fringe benefits, (b) consultant costs, and (c) diagnostic testing required to rule-out an MI in patients with chest pain. LOS data is also considered pertinent and will be included as a cost factor in this study. This data will be collected for a specified period of time. Maintenance, travel, and capital costs are not relevant and therefore will not be included in this study.

4. Analyzing the costs of each level of care alternative will include determining the unit of service costs and total cost per patient with chest pain for each level of care.
5. A sensitivity analysis will not be conducted because none of the costs in this study will be estimated.

In addition to the analysis of costs, an assessment will be made of the following patient outcomes: the number of patients at each monitoring level who are actually diagnosed with an MI and the number of patients returning to the hospital with a complaint of chest pain within 30 days of dismissal. Data on the number and type of diagnostic tests ordered to rule-out MI by physician specialty, length of stay, and TRICARE enrollment status will also be collected. It is important to determine if physician specialty, patient demographics, and co-morbidity differences between patients influence costs and length of stay. Therefore, these variables will be studied.

The research literature discusses the need to maintain diagnostic accuracy at alternative care delivery sites for patients with chest pain. The percent of patients diagnosed with an MI and recidivism rates are described in the literature as means of measuring diagnostic accuracy (DeLeon, Farmer, King, Manternach, & Ritter, 1989; Gaspoz, Lee, Cook, Weisberg, & Goldman, 1991; Gibler et al., 1995; Gomez, Anderson, Karagounis, Muhlestein, & Mooers, 1996; and Maag et al., 1997). The research literature also suggests that there is variability in physician's orders for diagnostic testing to rule-out an MI in patients with chest pain at alternative delivery care sites (Gomez et al., 1996). This variability in diagnostic testing by physician/physician specialty was also noted to increase expenses. The effect of TRICARE enrollment status on length of stay is not reported in the research literature, however, in a military medical treatment facility that also provides care to civilian patients with chest pain, it is important to evaluate whether enrollment status is a factor in length of stay. And finally, the research literature does not describe demographic characteristic and/or co-morbidity differences between patients with chest pain who are diagnosed with MI and those who are ruled-out for MI. This represents an area of inquiry that needs to be studied.

Summary

The cost analysis framework presented by Reynolds and Gaspari (1985) promotes study of selected cost measures pertinent to the operational problem. The framework provides

comprehensive guidance for cost analysis descriptive research and is appropriately used as the theoretical framework for this study that compares the costs. In conjunction with the costs it is important to determine patient outcomes: the length of stay, percent of recidivism for chest pain, and actual MIs diagnosed in each alternative monitoring site for patients who come to an emergency department complaining of chest pain (ICD-9 codes 78650 & 78659). It is also important to determine physician variability in diagnostic testing to rule-out MI, TRICARE enrollment status effects on length of stay, and demographic/co-morbidity differences between patients diagnosed with MI and those ruled-out for MI at each alternative monitoring site for patients who come to an emergency department complaining of chest pain. The framework's steps were first delineated as described by the authors (Reynolds & Gaspari) and then analyzed as they applied to this research.

Definition of Terms

For the purpose of this study, the following theoretical definitions of terms were used.

1. Body Mass Index (BMI) is defined as a person's relative fatness. In this study BMI was determined by: weight in kilograms / (height in centimeters)^2
2. Civilians are defined as people who are not on active military service, retired from the military service, or a family member of these two categories. Civilians may work on a military installation.
3. Co-morbidity is defined as an additional disease(s) or medical condition(s) reported by patients complaining of chest pain, and documented by the physician in their medical record. Examples of co-morbidities included: diabetes, coronary artery disease, cancer, renal failure, congestive heart failure, previous MI, heart block (any type), hypertension, hypercholesteralemia, and arrhythmias (atrial fibrillation, atrial flutter, and/or premature ventricular contractions).

4. Demographic characteristics are defined as vital statistic descriptors of patients complaining of chest pain. In this study demographic characteristics included: age, gender, height and weight (expressed as BMI), race, and TRICARE enrollment status.
5. Diagnostic testing to rule-out MI is defined as cardiac enzyme testing, electrocardiograms, and telemetry (heart) monitoring.
6. Inpatient is defined as a person who is formally admitted to the hospital as an inpatient with the expectation that he/she will remain in the hospital at least overnight (HCFA, 1989).
7. Inpatient Cardiology Unit is defined as a nursing care unit within an acute care hospital that provides services to inpatients with diagnosed or potential heart disease.
8. Length of stay is defined as total amount of time that a patient spent in the ED, outpatient observation unit, or the inpatient cardiology unit measured in minutes as indicated in the Corporate Executive Information System (CEIS) database.
9. Nursing or other staff is defined as licensed registered nurses (RNs) who have passed the National Council on Licensure Examination (NCLEX), Unlicensed Assistive Personnel (UAP) who are non-licensed staff members performing clinical duties under the supervision of an RN, and administrative personnel at the monitoring site.
10. Obese BMI is defined as a BMI greater than 35kg/cm^2 (Kushner, 1993).
11. Outpatient is defined as a person who is not formally admitted to the hospital but receives services from the hospital (HCFA, 1987).
12. Outpatient Observation Unit is defined as a designated unit within an acute care hospital that provides observation services, including the use of a bed and periodic monitoring by the hospital's nursing or other staff, that are reasonable and necessary to evaluate an outpatient's condition or determine the need for a possible admission to the hospital as an inpatient. Most of the services on this unit do not exceed 24 hours (HCFA, 1996).
13. Overweight BMI is defined as a BMI of 30kg/cm^2.

14. Physician specialty is defined as the physician caring for each patient; physician specialty is defined as their medical specialty, i.e., internal medicine (medicine), cardiology, or emergency medicine.
15. Recidivism is defined as a return to the military MTF with the complaint of chest pain within 30 days of dismissal from the ED, outpatient observation unit, or inpatient cardiology unit.
16. TRICARE enrollment status denotes whether a patient does or does not participate (enroll) in the military Health Maintenance Organization (HMO) for their region. TRICARE is the military HMO that services the region in this study. Military personnel who are on active military service are automatically enrolled in TRICARE. The families (spouses, children) of active duty military personnel have the option to enroll in TRICARE. Retired military personnel and their families have the option to enroll in TRICARE up to age 65; people over age 65 are not eligible for enrollment in TRICARE. Civilians are not eligible for enrollment in TRICARE.
17. TRICARE Senior Prime denotes a pilot program that enrolled retired military personnel and their families over age 65 on a limited basis.

Assumptions and Limitations

The cost analysis portion of this study assumes that accurate cost data are available. A limitation of this study is that retrospective cost, length of stay, recidivism, enrollment status, demographic, and co-morbidity data will be analyzed. Therefore bias may be introduced through selective survival of data, that is, the records available for data collection may not represent the entire set of all possible records. A further limitation of this study is that only one exemplar of each alternative patient monitoring site (ED, outpatient observation unit, & inpatient cardiology unit) will be used. Therefore the study findings can be generalized only to the hospital studied.

Chapter Summary

This chapter identified the purpose of this study and discussed the alternative methods of monitoring a patient who presents in the ED with chest pain (ICD-9 codes 78650 & 78659). The costs, length of stay, percent of MI diagnosis, and patient recidivism rate with the same diagnosis will be determined. In addition, physician variability in diagnostic testing to rule-out MI, insurance enrollment status effects on length of stay, and demographic/co-morbidity differences between patients diagnosed with MI and those ruled-out for MI will be examined for each alternative monitoring site for patients who come to an emergency department complaining of chest pain. The research theoretical framework, based on the Reynolds and Gaspari (1985) model, was identified. The research questions were stated and definitions specified. The study assumptions and limitations were also identified. Chapter II contains a review of the relevant literature. The study methodology is presented in Chapter III.

II. REVIEW OF LITERATURE

The purpose of this study is to compare the costs, the length of stay, the percent of patients diagnosed with an MI, and the recidivism rate of three alternatives for monitoring patients who come to an emergency department complaining of chest pain (ICD-9 codes 78650 & 78659) within a military medical treatment facility (MTF): ED, outpatient observation unit, and inpatient cardiology unit. In addition, (a) the number and type of diagnostic tests ordered to rule-out an MI by physician and physician specialty, (b) the effect TRICARE enrollment has on length of stay, and (c) demographic and co-morbidity differences between patients diagnosed with MI and those ruled-out for MI will be compared among the ED, outpatient observation unit, and inpatient cardiology unit. In this chapter, literature related to this problem is reviewed. Research is reported and implications for the current study are summarized.

According to the Cardiology Preeminence Roundtable (1997), in the United States, 5.5 million adults each year visit emergency departments with a primary complaint of chest pain. Although 87%, did not have a life-threatening cause for their chest pain, the "differential diagnosis of chest [pain] in adults includes entities with significant morbidity and mortality, among them myocardial infarction (MI)..." (Cardiology Preeminence Roundtable; Graff, 1993, p. 133). Myocardial infarction is the number one cause of death for adult Americans (Tallon, 1996). Four to eight percent of MIs are missed on initial evaluation in the emergency department (ED) and unintentionally discharged home, accounting for as much as 20% in liability losses (Graff).

Research has demonstrated that as many as 5 to 6 percent of patients with MIs have atypical signs and symptoms, accounting for the majority of the missed diagnoses and inadvertent discharges (Maag et al., 1997). To minimize a missed diagnosis of MI, inpatient evaluation of chest pain is often initiated (Zalenski et al., 1997). Patients whose admissions are to rule out MI account for up to 70% of admissions to Coronary Care Units in most acute care facilities and consume approximately $3 billion in public resources (Tallon, 1996; Zalenski et al).

Graff (1993) recommends extended observation and diagnostic studies to aid in ruling out MI as the cause of chest pain. Studies support this recommendation, demonstrating that the effectiveness of diagnostic testing, such as cardiac enzymes, improves the diagnosis of an MI from 50% to greater than 95% during extended observation. "Serial [electrocardiograms and cardiac enzyme] testing during monitored observation can accurately diagnose low and moderate probability patients with MI" (Maag et al., p. 315).

As health care costs continue to spiral upward and reimbursement for inpatient care continues to decrease, acute care facilities search for alternate sites to deliver quality care to patients with chest pain. Research has supported the implementation of emergency department observation units in conjunction with rapid rule out MI protocols as cost-effective methods of caring for patients with chest pain with a low-probability of MI (Gomez, Anderson, Karagounis, Muhlestein, & Mooers, 1996; Maag et al., 1997; and, Zalenski et al., 1997). These studies have examined charges and/or costs for personnel, laboratory (serial cardiac enzyme), serial ECG, stress test, and length of stay as pertinent costs.

Graff (1993) notes that only one-quarter of acute care facilities provide observation services within emergency departments. The majority of observation services, in contrast, are provided in designated units outside the emergency department (outpatient observation units), or in designated beds within inpatient units. Only one study examined the cost-effectiveness of the chest pain care provided in a non-ED observation delivery care site (DeLeon, Farmer, King, Manternach, & Ritter, 1989).

"Health and nursing costs are significant because of their economic effect and their likely connection to the quality of care and to health care policy". (Chang & Henry, 1999, p. 96). Fagin and Jacobson (1985) conducted the only integrated review of the cost literature in nursing. Their review examined 53 cost studies between 1975 and 1983. All of the studies were cost-effectiveness studies; 35 were experimental and 18 were non-experimental.

The studies fell into four categories: organization of nursing services; testing specific nursing interventions, substitution of nurses for other providers, and testing alternative models of practice (Fagin & Jacobson, 1985). Fourteen studies tested alternative models of practice. These studies examined costs when changes in traditional modalities of health care or the system for delivering care were introduced (Fagin & Jacobson). None of the studies examined the costs of alternative monitoring sites for patients with chest pain.

Chang and Henry (1999) conducted a review of the medical, health services, and nursing cost research published from January 1990 through August 1996. Only four nursing cost studies were found. All of the studies reviewed were cost-effectiveness studies (Chang & Henry). Again, none of the studies examined alternatives to monitoring patients with chest pain.

A comparison of the actual costs for monitoring patients with chest pain in alternate delivery sites and recidivism rates for chest pain is lacking. In this study actual costs will be used. The majority of the research literature reports the charges associated with chest pain care rather than the costs. Finkler (1982) notes, however, that "charges may bear little resemblance to economic costs [actual resource consumption], and use of charges as a proxy for economic cost may lead researchers to draw unwarranted conclusions about economic efficiency" (p. 102).

The effect of TRICARE enrollment status on length of stay is not reported in the research literature, however, in a military medical treatment facility that also provides care to people over age 65 and civilian emergency patients with chest pain, it is important to evaluate whether enrollment status is a factor in length of stay. The research literature on economic analyses also does not describe demographic characteristic and/or co-morbidity differences between patients with chest pain who are diagnosed with MI and those who are ruled-out for MI. In particular, the research literature on economic analyses does not include comparisons of patients' body mass index (BMI) measurements in demographic characteristic descriptions. Kushner (1993) notes that, " Historically, ideal or desirable weights have been defined as those associated with the

lowest mortality" (p.127). BMI measurements, however, provide an improved method for assessing percentage of body fat and associated mortality risk. "The BMI indicates the relative fatness of individuals and is...minimally correlated with height" (Kushner, p. 127). The Quetelet Index is the "de facto" criteria for defining a desirable weight index and is determined using the following formula: weight in kilograms / (height in centimeters)^2. Overweight is defined as BMI of 27.8kg/cm^2 or more in men and 27.3kg/cm^2 or more in women (Williamson, 1993). "Epidemiological studies show that excess body weight is associated with increased mortality" (Kushner, p.127). More specifically, a BMI greater than 35kg/cm^2 (obese) has been associated with a "two-fold increase in total mortality, and a several-fold increase in morbidity due to diabetes, ...and cardiovascular disease" (Kushner, p. 128).

There were no nursing cost studies found that examined alternatives to monitoring patients with chest pain. The International Council of Nurses (1992) notes that, "...understanding the professional importance of linking nursing's responsibility for quality of care with cost-effectiveness of that care is critical" (Chang & Henry, 1999, p. 95). Therefore, nursing research designed to gain insight into the costs of chest pain monitoring alternatives is pivotal.

Several components need to be examined when studying alternative care delivery sites for monitoring patients with chest pain. These components will be used to organize the review of literature:

1. The plausibility of observing patients with chest pain.
2. Outcomes of the management of patients with chest pain.
3. Pertinent cost measures in evaluating chest pain.

Observation of Patients with Chest Pain

The National Coalition on Health Care (NCHC) (1999) found that "Americans spend about one of every eight dollars on health care" (p. 1). This is four times the amount of money that was spent on health care in 1980 (NCHC). During this same time frame, household incomes doubled indicating, "health care costs have been rising at about twice the rate of income" (NCHC, p. 1).

Therefore, as individual incomes were out-paced by health care costs, individual consumer's ability to pay for health care declined. The federal government's involvement as a payer for health care subsequently increased with health spending currently 13.5% of the gross domestic product (GDP) (HCFA, 1997). In the U.S. 37% of the health care dollars spent are used to pay for hospital care (NCHC). This emphasizes the economic impact of inpatient hospital care as well as the necessity of finding cost-effective alternatives.

Choices regarding health care alternatives must consider not only the costs of the alternatives, but also the quality of the outcomes associated with the alternatives. There are two sites within acute care facilities that have the necessary personnel and equipment to provide observation services: emergency departments (EDs) and in-hospital units (Graff, 1993). Only one-quarter of acute care facilities provide observation services within EDs, accounting for two to five percent of total ED visits (Graff). ED observation units are staffed from within the emergency department with emergency physicians providing direct supervision of the patients (Graff). The majority of observation services, in contrast, are provided on designated in-hospital units (outpatient observation units), or in designated beds within inpatient units.

The Multicenter Chest Pain Study Group "has shown that 50 - 60% of patients who present to the ED with chest pain require an extended evaluation if virtually all of the patients with [acute MI] are to be identified" (American College of Emergency Physicians (ACEP) Information Paper, 1995, p. 1037). Wears, Li, Hernandez, Luten, and Vukich (1989), note that to evaluate all patients with chest pain who are at risk for having an MI through inpatient hospitalization would cost an estimated $1.5 million per life saved and a significant number of these patients, 55%, will subsequently have a non-cardiac cause for their chest pain (Weingarten et al. 1994). McGough (1997) documents a cost-savings of $ 2,000 per patient for chest pain patients evaluated in ED observation units. This translates into substantial savings nationwide with one billion dollars saved in the avoidance of 500,000 inpatient hospitalizations for the evaluation of chest pain.

Several studies changed the inpatient hospitalization paradigm for patient care, specifically the care of patients with chest pain. These studies empirically showed that the use of alternative sites improved patient outcomes. Graff, Mucci, and Radford (1988) compared a physician's clinical judgment with the DRG criteria for admission to determine their "reliability in predicting the need for hospitalization" (p. 943). This retrospective study of 350 patients in an ED-attached observation unit used clinical outcomes to "establish the correctness of the decision to hospitalize" (p. 943). The study concluded that the physician's clinical judgment outperforms the DRG criteria for admission in determining the need for inpatient hospitalization. The authors cautioned, however, that in this study the physicians had an average of 11 hours to observe the patients prior to making the decision for inpatient admission. Normal ED operations allow only 1 to 2 hours to make disposition decisions for either inpatient admission or discharge home (Graff et al.). Therefore, the authors surmised that physician clinical judgment regarding patient disposition from the ED might not perform as well without extended observation time (Graff et al.)

One alternative to ED patient monitoring or inpatient hospital monitoring is observation unit care. The use of observation units has evolved over the last 30 years to meet health care industry needs and provide an alternate care delivery site between the traditional outpatient setting, the inpatient setting, and the ED. (Graff, 1993).

Observation units help to solve the dilemma of how to care for patients who are too ill or require more intensive services than can be provided in a traditional outpatient setting (clinic, physician's office) but who do not require inpatient hospitalization, and/or those patients who's risk for a serious disease is high but not high enough for inpatient hospitalization (Graff, 1993).

"Differences in duration and intensity of service differentiate observation unit monitoring from other types of services provided in the acute care hospital" (Graff, 1993, p. 24). Traditional outpatient services are for patients with "limited intensity service needs" (Graff, p. 25) and inpatient services are for patients who require large amounts of nursing services per patient for

prolonged periods of time. ED services provide observation of patients often up to 8 to 12 hours before disposition, depending on the availability of consult services to evaluate and move patients to in-hospital settings (outpatient observation units or inpatient units). Outpatient observation services provide intensity of service equivalent to inpatient units, but for a limited duration of time, usually not to exceed 24 hours (Graff).

Observation services provided on outpatient observation units or in designated beds within inpatient units account for eight to 25% of hospital admissions (Graff). Outpatient observation units require a designated nursing staff and an attending physician follows each patient (Graff). Graff refers to the services provided on these units as "inpatient-outpatient" services (p. 24).

The principles guiding care on outpatient observation units as described by Graff (1993), evolved from the inpatient care model. Consistent with this model, observation units require an extensive history and physical examination; detailed orders planning for 24-hour patient care such as, diet, medications, reason for observation, treatment plan, diagnosis; progress notes to document the patient's condition throughout his/her stay; and, disposition plans (Graff, 1993). Observation services also rely heavily on formal protocols, procedures, and guidelines to ensure "optimal patient care for defined clinical conditions", such as chest pain evaluation (Graff, p. 29).

The literature supports the plausibility of observation units as an alternative delivery site for patients with chest pain citing both improved care and decreased health care costs (Zun, 1990; Silverstein & Ward, 1999). Outpatient observation units provide an improvement over typical outpatient care because patient observation over time increases the level of care received and more time for evaluation improves diagnostic and disposition decisions (Zun).

Lee et al. (1987) studied the minimum time required to diagnose an MI. They studied 1,460 patients admitted to intensive care (ICU) or intermediate care units with chest pain. Serial enzyme testing was initiated on all patients after admission to the ICU or intermediate care units resulting in 431 patients diagnosed as having MIs. In this population, an MI was diagnosed in 331 (77%) of the patients within 12 hours while 415 (96%) of the patients were diagnosed within

24 hours. The authors found that the absence of recurrent chest pain and normal cardiac enzyme results from serial testing were sufficient to identify chest pain patients at low-risk for MI. The researchers concluded that "24 hours is nearly always a sufficient period to exclude myocardial infarction in patients without recurrent chest pain" (p. 181). Lee et al. also noted that the "findings emphasize the potential for reducing use of the intensive care unit and increasing efficiency" (p. 185).

Lee et al. (1991) in a follow-on study hypothesized that 12 hours might be an adequate period to evaluate chest pain in patients with a low probability of MI on admission. The authors developed an algorithm to predict patients' risk of MI. They classified 957 patients as low-risk for MI and observed these patients for 12 hours using cardiac enzyme abnormalities and/or recurrent chest pain as the methods to rule-out MI. Seven hundred seventy-one (80.6%) of the patients were ruled-out for an MI on the basis of normal cardiac enzyme results and non-recurrent chest pain. Only four of these patients were later found to have suffered an MI. The authors concluded that cardiac enzyme results and chest pain recurrence data are useful "to identify a large subgroup of patients for whom a 12-hour period of observation is normally sufficient to exclude acute MI" (p. 1239). The authors' noted that this data could be collected in the ED rather than imposing intensive care unit rule-out MI protocols on all patients with complaints of chest pain.

Fineberg, Scadden, and Goldman (1984) conducted a "cost-effectiveness analysis to examine the clinical and economic consequences of alternatives to admission to a coronary care unit (CCU)" for patients with chest pain that have relatively low probability of MI (p. 1301). The authors studied the rates of early mortality and long-term survival, and the economic costs of caring for patients with chest pain in four alternative sites: CCU, an intermediate care unit with resuscitative equipment and the ability to administer prophylactic lidocaine to control arrhythmias, a routine hospital unit, and outpatient (home) care. The results of the study showed that the intermediate care unit was the most cost-effective site for the care of patients with chest

pain at low-risk for MI. This study lends support to the plausibility of an intermediate site, between the traditional outpatient setting and the inpatient setting, for the care of patients with chest pain.

In a study of 12,139 ED patients with chest pain Tosteson, Goldman, Udvarhelyi, and Lee (1996) used a decision-analytic model to "identify cost-effective guidelines for the admission to a coronary care unit" (p. 143). The authors found that the CCU was not cost-effective for patients with chest pain who did not have ECG changes suggestive of MI and who did not suffer from hypotension, heart failure, and/or arrhythmias. The authors note that this finding is consistent with other studies that showed that patients with chest pain but without "changes on their initial ECGs are unlikely to have life-threatening complications...[and] are at low risk for developing [MI]" (p. 149). Tosteson et al. recommended the use of intermediate care units for the evaluation of patients at low-risk for an MI and proposed that future studies investigate cost-effective management strategies in caring for these patients.

Gaspoz, Lee, Cook, Weisberg, and Goldman (1991) investigated the outcomes of patients admitted to a short-stay coronary observation unit, adjacent to the ED, for the evaluation of chest pain. The study evaluated 512 patients with chest pain; 425 (83%) did not have an MI or serious complications and were discharged home from the coronary observation unit. The researchers used serial cardiac enzyme and electrocardiogram (ECG) testing to rule-out MI. Serious complications were considered to be: death, arrhythmias, and heart failure. A 6-month follow-up of the 425 patients discharged directly from the coronary observation unit revealed a survival rate of 99%. The authors concluded that the coronary observation unit was a safe alternative site for the care of patients with chest pain with a low-probability of an MI. The authors included per diem charges and nurse to patient ratios for the coronary care unit ($1,040 and 1:1/1:2), the step-down unit ($625 and 1:3/1:4), inpatient units ($450 and 1:5), and the coronary observation unit ($415 and 1:5). The charges for the coronary observation unit were less than the other patient care delivery alternatives. Although the authors note that charges

may not reflect actual costs they surmise that actual costs will remain less on the coronary observation unit because the nurse to patient ratios are the same or lower than the other alternatives.

The previous studies changed the inpatient admission paradigm concluding that: (a) A period of observation may improve physician decision-making ability regarding the need for inpatient admission, (b) chest pain can safely be evaluated in less than 24 hours outside intensive care units by using clinical data available in the ED, (c) the CCU is not cost-effective for evaluating patients with chest pain at low-risk for MI, and (d) observation unit care is safe in evaluating chest pain with low-probability of MI.

With reimbursement of inpatient admissions currently controlled by DRG medical necessity criteria, these studies provide a framework supporting the feasibility of extended outpatient evaluation of chest pain for up to 24 hours. These studies primarily evaluated the feasibility of ED observation and did not examine the use of outpatient observation units located elsewhere in acute care facilities. The American College of Emergency Physicians (ACEP Information Paper, 1995) considers ED observation a "more feasible site to evaluate the patient with chest pain having a low probability of [MI]" (p. 1037).

The literature also supports the plausibility of observation units as lower cost sites for the care of patients with chest pain. Graff (1993) states, "The primary impetus for the delineation of observation services has been the financial savings available to the health care payer...shown to be significant in the past" (p. 29). Both Graff and Zun (1990) attribute the financial savings of ED observation units to: shorter length of stay; lower costs for services, including a decrease in the number of tests performed; lower charges for care, reflecting an hourly rate for observation care as opposed to the inpatient DRG rate; and avoidance of the costs for inpatient hospitalization, by decreasing the actual number of inpatient admissions. Zun further notes that the shorter length of stay on ED observation units reflects increased physician visits to patients on these units as opposed to inpatient medical/surgical units.

Farrell (1982) studied an ED observation unit in a community hospital and described cost-savings in the amount of $290,000 per year. These cost-savings, according to Farrell, were attributable to an inpatient bed-day reduction of 620 days. In this study the author did not specifically examine patients with chest pain or at outcomes.

The ACEP Information Paper (1995) suggests that the cost for observation of chest pain patients in the ED is 20 - 50% less than the cost of inpatient chest pain management. These findings are based, in part, on the Emergency Medicine Cardiac Research Group's studies that demonstrate that an MI can be effectively diagnosed in an ED observation unit using serial cardiac enzyme testing and serial ECG monitoring in less than 24 hours (Gaspoz, Lee, Cook, Weisberg, & Goldman, 1991; and Hoekstra et al., 1994). DeLeon et al. studied the cost-effectiveness of a Chest Pain Evaluation Unit (CPEU). The CPEU used unoccupied intensive care and intermediate care unit beds to observe patients with chest pain. The cost of CPEU care was significantly less than CCU care ($598 compared to $3,103 for a CCU stay). Length of stay was substantially shorter in the CPEU (11.1 hours) as compared to the CCU (3 days) and was proposed to have been the major factor in the cost differences between the two units. Graff agrees that the "amount of savings per patient observed depends on shortening the length of stay" (p. 99).

Silverstein and Ward (1999) state,

> "...there is a growing (but not definitive) body of evidence supporting protocol-driven evaluation of chest pain in the ED setting, allowing fewer admissions for rule-out MI with low risk of discharging a patient with an MI to home. Significant cost savings may be able to be achieved. The key appears to be rapid turn-around of tests [and] availability of noninvasive cardiac evaluation..." (p. 4).

Zalenski et al. (1997) warn, however, that the cost savings realized with ED observation units are related to their ability to observe and then discharge patients. When patients are observed and then admitted to an inpatient unit, the cost for care is actually higher because the cost of

observation is added to the inpatient cost. Therefore, the percentage of discharges from observation units must be higher than the percentage of inpatient admissions from these units in order for them to be cost saving.

Summary

Research indicates that observation units are effective care delivery alternatives for patients experiencing chest pain. This research has focused primarily on ED observation units indicating that these areas can provide improved care at lower costs. The greatest determinant of cost savings appears to be length of stay. Several studies demonstrated that potential chest pain complications, such as MI, could be safely ruled-out in less than 24 hours in patient care delivery sites other than intensive care units. ED observation of patients over a period of time was demonstrated to enhance physician decision-making ability regarding the necessity of inpatient admission. It was concluded that this time element was critical in adequately assessing disposition requirements for patients with chest pain, i.e., inpatient hospitalization or discharge home. Only one study was found that examined the cost-effectiveness of an observation unit using designated beds within an inpatient unit for the observation of patients with chest pain (DeLeon et al., 1989). Since length of stay costs are a major area of concern when caring for patients they will be included in this study.

Chest Pain Management Outcomes

Studies by the multicenter Chest Pain Study Group (CPSG), and others, have characterized the presentation and outcome of adults with chest pain. These studies have examined only patients who were 30 years of age or older (Fineberg et al., 1984; Gibler et al., 1992; Gomez et al., 1996; Lee et al., 1987; Lee et al., 1991; Toteson et al., 1996; Weingarten et al., 1994).

There are several variables for evaluating the outcomes of chest pain care reported in the literature. Gomez, Anderson, Karagounis, Muhlestein, and Mooers (1996) hypothesized that a rapid rule-out MI protocol used in an ED-based Chest Pain Evaluation Unit (CPEU) would maintain diagnostic accuracy while reducing both hospital time and expense. One hundred

patients with chest pain, but low-risk for MI, were randomized to either the rapid rule-out MI protocol or to routine hospital care. The rapid rule-out MI protocol included serial cardiac enzyme testing every 3 hours for a total of four tests (12 hours), serial ECGs with continuous ST segment monitoring, and if ruled-out, an exercise stress test prior to discharge from the CPEU. Patients randomized to routine hospital care were cared for by their attending physicians and received diagnostic testing according to each individual physician's orders. Diagnostic accuracy was measured by the percent of patients who ruled-in for MI and the number of missed diagnoses within 30 days of discharge. The authors noted that only one patient in each group was diagnosed with MI therefore, the difference between the groups was not significant. Only three patients in each group returned to the hospital within 30 days with complaints of chest pain; all three subsequently ruled-out for MI. The authors also measured the percent of cardiac chest pain and non-cardiac chest pain in the patients who had ruled-out for MI finding that the majority (93%) had non-cardiac chest pain. The authors note that the care in the routine hospital group was much more variable (physician-dependent) with this group undergoing more expensive testing much more frequently than the rapid rule-out protocol group. Gomez et al. concluded that an ED-based rapid-rule out protocol is effective in ruling out MI. They recommended that a larger study be conducted, noting that the small sample size in their study limited comparability.

Gaspoz, Lee, Cook, Weisberg, and Goldman (1991) evaluated an ED short-stay coronary observation unit's effectiveness in ruling-out MI in 512 patients with chest pain. All the patients underwent serial cardiac enzyme testing every 8 hours for up to 24 hours and serial ECG recordings every 12 hours. Myocardial infarction was diagnosed in 15 (3%) and ruled-out in 97% of the patients in the coronary observation unit. Four hundred and twenty-five patients were sent home directly from the coronary observation unit without evidence of MI and of these patients only 1.2% had an MI within 72 hours. Eighty-seven (17%) of the patients were transferred to other levels of care and 11 of these patients were diagnosed with MI. Twenty-one

(24%) patients were transferred to the CCU, 36 (41%) patients were transferred to the step-down unit, and 30 (35%) patients were transferred to routine hospital units. In this study, patients were transferred to an inpatient setting if they were definitively diagnosed with an MI based on abnormal cardiac enzyme results and/or significant ECG changes, or if they had complications. Complications included: heart block (new, progressing, or third degree); recurrent chest pain, congestive heart failure, unstable arrhythmias, pulmonary embolism, and other. The authors' note, "the final diagnosis of acute myocardial infarction...[was] higher among patients who were transferred [to other levels of care]...and length of stay were longer" (pp. 147-148). A 6-month follow-up revealed a survival rate of 98.8% in patients evaluated in the coronary observation unit; only eight patients were subsequently diagnosed with MI in this time frame. The authors' concluded that the coronary observation unit was safe for chest pain evaluation of patients with a low-risk for MI. They recommended that mandatory stress testing prior to discharge be conducted to aid in diagnosing coronary artery disease in patients who ruled-out for MI.

Gibler et al. (1995) evaluated a 9-hour diagnostic evaluation for patients with chest pain in an urban tertiary care ED. A retrospective review of 1,010 patients enrolled in the Heart ER Program was conducted. The 9-hour diagnostic evaluation consisted of serial cardiac enzyme testing every 3 hours for a total of four sets (9 hours), continuous ECGs with ST segment monitoring, and exercise stress testing after the 9-hour evaluation was completed. After the 9-hour evaluation 829 (82.1%) patients were ruled-out for MI and were discharged to their homes. Thirty-day follow-up revealed only two patients subsequently suffered an MI after a negative evaluation in the Heart ER. The authors found the 9-hour diagnostic evaluation in the Heart ER to be effective for evaluating chest pain in patients at low- to moderate-risk for MI. They cited the systematic approach of the 9-hour protocol as the key to its effectiveness.

Tosteson, Goldman, Udvarhelyi, and Lee (1996) used the decision-analytic model to conduct a cost-effectiveness analysis of two alternative hospital sites for the care of patients

with chest pain: coronary care unit and intermediate care unit. Effectiveness was assessed for 901 patients relative to whether they were ruled-out or ruled-in for an MI, the probability of complications and/or death within 48 hours, and the probability of complications and/or death after 48 hours. Study results demonstrated that the "cost-effectiveness of the coronary care unit as the initial level of care for emergency department patients with acute chest pain is highly dependent on probability of acute myocardial infarction" (p. 148). The authors found that the coronary care unit only became cost-effective when the probability for MI exceeded 19% (moderate risk). Therefore, the authors concluded that intermediate care units were more appropriate for the evaluation of patients with chest pain at low- to moderate-risk for MI.

DeLeon, Farmer, King, Manternach, and Ritter (1989) compared the cost-effectiveness of evaluating chest pain in a Chest Pain Evaluation Unit (CPEU) with a coronary care unit (CCU) evaluation for these same patients. The CPEU was located in unoccupied beds in either the intensive care or intermediate care units. Diagnostic evaluation in the CPEU consisted of ECG monitoring and serial cardiac enzyme testing every two hours for up to five sets. Four hundred and ninety-five patients were evaluated in the CPEU using this diagnostic evaluation with 327 ruled-out for MI and diagnosed with non-cardiac chest pain. The remaining 168 patients were admitted to the CCU, an intermediate unit, or a standard hospital room. Only 30 (18%) of the 168 patients admitted to inpatient units were diagnosed with MI. Readmission within 48 hours of release from the CPEU was measured by questionnaire or telephone contact. One hundred and sixty-seven patients of the 327 that were ruled-out and released were able to be contacted and none had required readmission within 48 hours or suffered any complications. The authors concluded that the majority of patients were effectively ruled-out in the CPEU and sent home without readmission or complications within 48 hours.

Summary

"Diagnosing or excluding patients with myocardial infarction with acute chest pain in the emergency room is a challenging task" (Lee et al., 1987, 181). The literature reviewed showed that the variables used to evaluate the outcomes of chest pain management are:

1. The percent of patients who are ruled-in for myocardial infarction.
2. The percent of patients who are ruled-out who have a cardiac cause for chest pain.
3. The percent of patients who are ruled-out who have a non-cardiac cause for their chest pain
4. The percent of patients who are subsequently diagnosed with MI (missed MI) within a specified period of time after release from the hospital.

The review of the research literature also described variability in the type and expense of diagnostic testing to rule-out MI among physicians in alternative patient care delivery sites. It is important to determine if these variances affect costs at each level of care.

Cost Measures

Reynolds and Gaspari (1985) recommend that in a cost analysis only the pertinent costs of each alternative be analyzed. Pertinent costs are those program costs that differ for each alternative. Various cost measures related to the care of patients with chest pain are presented in the literature.

The DeLeon et al. (1989) study compared the costs of evaluating non-cardiac chest pain in a Chest Pain Evaluation Unit (CPEU) with the cost of coronary care unit (CCU) evaluation for these same patients. Diagnostic evaluation in the CPEU consisted of ECG monitoring, serial cardiac enzyme testing every two hours for up to five sets, and observation and treatment by nursing staff. Although the authors do not delineate their cost data, they determined that CPEU care for "non-MI chest pain" costs $598 compared to $3,103 for a CCU stay. The length of stay was significantly lower for patients in the CPEU (11.1 hours) as compared to the CCU (three days) and the authors' noted that the "major portion of the savings is in the shorter stay" (p.

1088). The authors' conclude that the CPEU is more cost-effective than CCU, intermediate, and/or standard hospital room care for chest pain evaluation. They further attribute cost-savings to the effective use of empty intensive care room beds for observation patients.

Zalenski et al. (1997) studied the feasibility of a rapid rule-out MI protocol for patients with chest pain in an ED chest pain observation unit (CPOU). Although they did not specifically study the costs of the CPOU they do note that "the fraction of CPOU patients discharged home rather than admitted to hospital is a key determinant of economic viability" (p.106). They further note that the costs for observing patients will increase as more patients are admitted to inpatient units, but that these costs may still be less than inpatient admission alone. Observation units will not be feasible, however, from a health care payer's perspective if the cost per patient exceeds inpatient costs.

Finefrock (1994) relates charges for an urban tertiary care center that provides observation care in the emergency department. Observation care in this ED is provided in three adjoining observation units with a total of 18 beds. Two of the units have equipment to perform continuous cardiac monitoring. Each unit has a nursing station and is staffed with ED nurses. Meals are provided for the patients through hospital dietary services. Chest pain evaluation accounts for 46% of the patient load and the highest charges. Serial cardiac enzyme testing, serial ECGs, and continuous cardiac monitoring are conducted to evaluate patients with chest pain and the average length of stay is 12 hours. With the addition of stress testing an observation charge for chest pain evaluation is approximately $1,600 as opposed to $2,000 for an inpatient admission for chest pain. Finefrock notes that observation units provide cost-effective care but warns that it is "counterproductive to establish an observation unit unless a significant number of patients go home" (p.488).

Zun (1990) discusses the nursing staff costs for an ED observation unit consisting of five beds. Nursing staff consists of at least one nurse on the unit at all times to meet ACEP guidelines for observation care. This equates to approximately five full-time equivalents (FTEs)

for 24-hour coverage. At an average salary of $21,127 nursing staff costs total $106,000 not including benefits. Zun assumes that other operating costs in the observation unit, such as laboratory and radiology, and procedures such as ECGs, will not vary from those on an inpatient unit.

Mikhail, Smith, Gray, Britton, and Frederiksen (1997) examined the cost-effectiveness of incorporating mandatory stress testing into a nine-bed chest pain center (CPC) adjacent to an ED. These authors used the financial software system in their facility to determine the total cost of chest pain evaluation in the CPC. Personnel, equipment, laboratory, pharmacy, cardiology, radiology, and supply costs were included in determining total costs. Patients in the CPC underwent serial cardiac enzyme testing and continuous ST-segment testing to rule-out MI. Stress testing was performed on 424 patients. Staffing consisted of one RN and one emergency technician per shift and 24-hour ED physician supervision. A retrospective sample of patients who ruled-out for MI and were sent home from the CPC were compared with similar patients who were hospitalized. The average length of stay in the CPC was 12 hours and 45 minutes. The total cost for CPC care was $894 including stress testing. This represents a 62% decrease in cost over the inpatient cost of $2,364. The authors found that the incorporation of mandatory stress testing was cost-effective for chest pain evaluation in the CPC.

In the Gomez et al. (1996) study, a rapid rule-out protocol was compared with routine hospital care for cost-effectiveness. Hospital charges were used to evaluate cost-effectiveness. These charges included: 1) room charges, which included nursing care for the routine hospital group and a flat rate for the rapid rule-out group; 2) laboratory charges; 3) pharmacy charges; and 4) test/procedures which included any tests or procedures conducted to rule-out MI, including cardiac enzyme testing, ECGs, stress testing, etc. Length of stay was also evaluated and was substantially shorter for the rapid rule-out group than the routine hospital group (12.1 hours versus 22.3 hours, respectively). The researchers found that the charges for the rapid rule-out group were $895 as compared to $1,488 for the routine hospital group. This represents

a 40% reduction in charges for the rapid rule-out care. Although the authors' concluded that the rapid rule-out protocol was cost-effective, they noted that the use of hospital charges rather than actual costs was a weakness in their study. They recommended that future cost-effectiveness studies examine actual operating costs.

Miller (1999) compared the costs of observation unit nursing staff on a 22-bed observation unit, managed by the ED, to the costs of inpatient unit nursing staff. He found that an inpatient medical/surgical unit required four RNs, four UAPs, and one administrative clerk to care for 16 patients at a cost of $350 per day. The observation unit required five RNs, one licensed vocational nurse (LVN), and one administrative clerk to care for 16 patients at a cost of $278 per day. No significant savings was noted for ancillary (non-RN) staffing. Miller also evaluated cost per hour of care on both units determining that observation care cost $8.63 per hour compared to medical/surgical inpatient care costs of $14.38. Miller then derived the average cost of care per day on each of the units (personnel costs per shift, unit volume, average length of stay (ALOS), number of staffed beds, and percent occupancy) as: $207 cost per day on the observation unit and $345 cost per day on the medical/surgical unit. In this cost comparison, the data show length of stay as the greatest determinant of cost. Length of stay was significantly lower on the observation unit (17 hours versus 3.8 days for inpatient LOS), while the other cost factors were higher, including RN staffing (4 RNs per shift on observation versus 3 RNs on the inpatient unit).

Summary

The literature reviewed showed that the cost measures that are pertinent in evaluating chest pain at differing levels of care include: 1) personnel (staffing) costs; 2) diagnostic testing; and 3) length of stay.

Chapter Summary

This chapter reviewed the current literature related to the monitoring of patients with chest pain at alternative patient care delivery sites. First, the usual sites for monitoring patients with

chest pain were presented: the ED and the inpatient cardiology unit. The newer concept of utilizing outpatient observation units was presented. Only one study has compared the costs of an outpatient observation unit with other monitoring sites. All units were found to provide safe care. Next, the outcome variables for patients with chest pain were delineated from current research studies as: percent of patients who rule-in for MI, percent of patients who have a cardiac cause or a non-cardiac cause for their chest pain, and recidivism related to missed MI diagnoses within 30 days of release from the hospital. The variability in diagnostic testing among physicians and the impact on cost at alternative delivery care sites was also described. Finally, the cost data pertinent to the evaluation of chest pain at alternative patient care delivery sites were described. The use of actual costs rather than charges has not been widely reported in the research literature. Gomez et al. (1996) recommended that future economic analyses use actual costs. Nursing research related to alternatives for monitoring patients with chest pain has not been reported in the cost literature. There are no cost analysis studies that have compared outpatient observation units with other monitoring sites within a military MTF.

III. METHODOLOGY

The purpose of this study was to compare the costs, and patient outcomes of actual diagnosis of MI and recidivism rate, of three alternatives for monitoring patients who came to an emergency department complaining of chest pain (ICD-9 codes 78650 and 78659) in a military medical treatment facility (MTF). In addition, this study compared the (a) number and type of diagnostic tests ordered to rule-out MI by physician specialty, (b) TRICARE enrollment status and length of stay, and (c) demographic and co-morbidity differences between patients diagnosed with MI and those ruled-out for MI, among the three alternative delivery care sites for monitoring patients with chest pain. This chapter addresses the research design, operational definitions, setting, sample selection, data collection procedure, and plans for data analysis for this study.

Research Design

The research design used in this study was a retrospective descriptive cost analysis. In a descriptive design the study variables are not manipulated, instead events are examined and described as they naturally occurred (Polit & Hungler, 1999). In this study only data from existing records of patients monitored for chest pain were examined. This study design allowed examination of the management of patients with chest pain as it actually occurred and the resultant costs in the three alternative patient care delivery sites (ED, outpatient observation unit, inpatient cardiology unit).

The questions for this descriptive study were, for patients monitored for chest pain in the ED, outpatient observation unit and inpatient cardiology unit:

1. What are the differences in length of stay?
2. What are the differences in costs for nursing staff, diagnostic testing, consultant, and length of stay?

3. What is the difference in percent of patients who present with chest pain and who are ultimately diagnosed with an MI?
4. What are the differences in the recidivism rate for returning to the MTF within 30 days with the complaint of chest pain?
5. What are the differences in physician specialty and the type and number of diagnostic tests ordered to rule-out MI in patients?
6. What are the differences in length of stay for patients enrolled in TRICARE and not enrolled in TRICARE?
7. What are the differences in the demographic characteristics and co-morbidities of patients diagnosed with MI and patients ruled-out for MI?

The explanatory variable in this study was the unit that monitored the patient with chest pain: ED, outpatient observation unit, or inpatient cardiology unit. The outcome variables in this study included: (a) the costs of nursing care and monitoring patients with chest pain on each unit, (b) the percent of monitored patients diagnosed with an MI on each unit, (c) the percent of monitored patients on each unit who return with a complaint of chest pain within 30 days of dismissal, (d) the length of stay for patients with chest pain on each unit, (e) the type and number of diagnostic tests ordered to rule-out MI by physician specialty on each unit, (f) the length of stay for TRICARE and non-TRICARE patients on each unit, and, (g) the differences in demographic characteristics and the number of co-morbidities in patients diagnosed with MI and patients ruled-out for MI on each unit .

The pertinent costs for each unit that monitored patients with chest pain included the following: nursing staff for length of stay, consultant fees, and diagnostic testing. The percent of monitored patients who are ultimately diagnosed with an MI and the recidivism rate were used to measure the outcome of the management of patients with chest pain in the ED, outpatient observation unit, and inpatient cardiology unit.

In this study the demographic and co-morbidity characteristics among patients with chest pain monitored in the ED, outpatient observation unit, and inpatient cardiology unit were examined. Demographic and co-morbidity characteristics in patients diagnosed with an MI were compared with those same characteristics in patients who were ruled-out for an MI to determine if there were any differences among the alternative patient care monitoring sites.

The type and frequency of diagnostic tests and procedures ordered to rule-out an MI in patients with chest pain were compared with physician specialty data to determine if there were any differences. Lastly, TRICARE enrollment status was compared with length of stay (LOS) data to determine if there were any differences in LOS for patients enrolled in TRICARE versus patients not enrolled in TRICARE. This information is of interest in a military MTF that also provided emergency care to civilian patients with chest pain.

Operational Definitions

The following operational definition of terms are used in this study:

1. Attending physician is defined as a physician who has completed medical school and a post-graduate residency program in the medical specialties of internal medicine (medicine), cardiology, or emergency medicine.
2. Body Mass Index (BMI) is defined as a person's relative fatness. In this study BMI was determined by: weight in kilograms / (height in centimeters)^2.
3. Co-morbidity is defined as an additional disease(s) or medical condition(s) reported by patients complaining of chest pain, and documented by the physician in the medical record. Examples of co-morbidities include: diabetes, coronary artery disease, cancer, renal failure, congestive heart failure, previous MI, heart block (any type), hypertension, hypercholesteralemia, and arrhythmias (atrial fibrillation, atrial flutter, and/or premature ventricular contractions).

4. Demographic characteristics are defined as vital statistic descriptors of patients complaining of chest pain. In this study demographic characteristics included: age, gender, weight, height (expressed as BMI), race, and TRICARE enrollment status.
5. Diagnostic testing to rule-out MI is defined as the cardiac enzyme testing, electrocardiograms, and telemetry monitoring used in the ED, outpatient observation unit, and inpatient cardiology unit to determine whether or not a patient with chest pain actually had an MI.
6. Family member prefix (FMP) is defined as a 2-digit code preceding the social security number. In the military medical system persons eligible for care are classified under the active military service members' (sponsors') social security numbers. The FMP identifies whether the patient with a given social security number is the sponsor (military member on active service), dependent spouse, dependent child, etc.
7. "Heart risk" co-morbidities are defined as the co-morbidities that may increase the risk of heart disease/MI and included: diabetes, congestive heart failure, previous MI, hypertension, hypercholesterolemia, and coronary artery disease.
8. International Category of Diagnosis, 9th edition (ICD-9) is defined as the code that identifies the patient's discharge diagnosis. For the purposes of this study the following ICD-9 codes were used:
    a. 78650 (rule-out MI cardiac chest pain)
    b. 78659 (rule-out MI non-cardiac chest pain)
    c. 41000 (MI, unspecified episode of care)
    d. 41001 (MI, first episode of care)
    e. 41002 (MI, subsequent episode within eight weeks)
    f. 4101 - 4109 (MI)
    g. 41200 (Old MI, greater than eight weeks)

9. Length of stay is defined as total amount of time a patient spent in the ED, outpatient observation unit, or the inpatient cardiology unit measured in minutes as indicated in the hospital records.
10. Obese BMI is defined as a BMI greater than 35kg/cm² (Kushner, 1993).
11. Overweight BMI is defined as a BMI of 30kg/cm².
12. Physician specialty is defined as medical specialty of the attending or resident physician caring for each patient, i.e., internal medicine (medicine), cardiology, or emergency medicine.
13. Recidivism rate is defined as a return to the military MTF with the complaint of chest pain within 30 days following dismissal from the ED, outpatient observation unit, or inpatient cardiology unit .
14. Resident physician is defined as a physician who has completed medical school and is enrolled in a post-graduate residency program in the medical specialties of internal medicine (medicine), cardiology, or emergency medicine.
15. Telemetry monitoring is defined as the electronic transmission of the heart's electrical impulses in the form of a heart rhythm on a computer monitor screen (Taber's Cyclopedic Medical Dictionary, 1974).
16. TRICARE enrollment status denotes whether a patient does or does not participate (enroll) in the military Health Maintenance Organization (HMO) for his/her region. TRICARE is the HMO that services the region in this study. Military personnel who are on active military service are automatically enrolled in TRICARE. The families (spouses & children) of active duty military personnel have the option to enroll in TRICARE. Retired military personnel and their families have the option to enroll in TRICARE up to the age of 65; people over the age of 65 are not eligible for enrollment in TRICARE. Civilians are not eligible for enrollment in TRICARE.

17. TRICARE Senior Prime denotes a pilot program at the study site that enrolled retired military personnel and their families over age 65 on a limited basis.

Setting

This research study was conducted in a 235-bed military medical treatment facility in the Southwest United States. This facility was a full service medical center with a Level One trauma center (hence referred to as the ED) that received 25% of the community's Code 3 civilian emergencies. The facility also provided patient care for over 15,000 inpatient admissions, 60,000 ED visits, and one million clinic visits per year. This facility was a teaching hospital for physicians; therefore teams of physicians consisting of attending and resident physicians cared for patients. The resident physicians rotated to a new service every six to eight weeks with a new attending physician.

Emergency Department. The emergency department was located in the basement of the hospital and consisted of a major emergency area and a minor care clinic. The major ED area was used to care for patients with serious injuries or potentially serious conditions. This area had two trauma rooms for the care of patients who have suffered traumatic injuries, and six monitored beds for the care of patients with serious medical conditions, such as chest pain. Daily nursing staff in the ED consisted of 12-13 RNs, and 25-30 UAPs.

Patients who came to the emergency department complaining of chest pain might be monitored for six to eight hours or more before a decision was made to send them home or transfer them to an in-hospital setting (outpatient observation or inpatient unit). In the facility being studied, ED physicians could not transfer patients to an in-hospital setting; they had to consult the medicine or cardiology service to move the patient.

Outpatient Observation Unit. The outpatient observation unit was a 26-bed unit located on the third floor of the MTF. The unit provided observation services 24 hours per day, seven days per week to evaluate and treat outpatient conditions and/or determine the need for inpatient hospitalization. The daily nursing staff on the outpatient observation unit consisted of 5 RNs and

7 UAPs. This unit provided care for patients referred from 18 medical and surgical clinical services. Patients with chest pain accounted for approximately 30% of the patient population. The unit had telemetry monitoring capability. In the study site, when patients were placed on telemetry monitoring, trained personnel constantly viewed their heart rhythm on the computer monitor screen. CCU telemetry technicians performed this function for patients being monitored in the outpatient observation unit. These technicians used a dedicated telephone line to alert the RNs in the outpatient observation unit to any abnormal heart rhythm(s) in the patients being monitored. The CCU was located around the corner from the outpatient observation unit.

Inpatient Cardiology Unit. The inpatient cardiology unit was a 30-bed unit located on the third floor of the MTF. The unit provided inpatient services 24-hours per day, seven days per week for patients referred from cardiology, internal medicine, and cardio-thoracic surgery services. The daily nursing staff on the inpatient cardiology unit consisted of 7 RNs and 8 UAPs. Patients with chest pain accounted for approximately 30% of the admissions to the unit. The unit had telemetry monitoring capability. In the study site, when patients were placed on telemetry monitoring, trained personnel constantly viewed their heart rhythm on the computer monitor screen. CCU telemetry technicians performed this function for patients being monitored in the outpatient observation unit. These technicians used a dedicated telephone line to alert the RNs in the outpatient observation unit to any abnormal heart rhythm(s) in the patients being monitored. The CCU was located next to the inpatient cardiology unit.

Sample

The study sample was drawn from all eligible records of patients who were discharged between November 1, 1998 and April 30, 1999 with a primary discharge diagnosis of chest pain (ICD-9 codes 78650 & 78659) or MI (ICD-9 codes 4100, 41001, 41002, 4101 – 4109, & 41200). The subjects included in this study were 30 years of age or older. Studies by the multicenter Chest Pain Study Group (CPSG), and others, have characterized the presentation and outcome of adults with chest pain. These studies have enrolled only patients who were 30 years of age or

older (Fineberg et al., 1984; Gibler et al., 1992; Gomez et al., 1996; Lee et al., 1987; Lee et al., 1991; Toteson et al., 1996; Weingarten et al., 1994). Therefore, excluding patients under 30 years of age as study subjects reflected consensus with the research literature regarding the study of patients with chest pain. The sampling period was divided into four 6-week segments with approximately one-quarter of the patient records selected from each 6-week segment for each monitoring site. This sampling method was intended to control for any potential bias that could be introduced since the study site was a teaching facility where resident physicians rotated to a new clinical service every 6 weeks. Patient records were excluded from this study only if they indicated that the patient was initially evaluated for chest pain in a site other than the ED.

The total sample for the study consisted of 167 records. The population for the inpatient cardiology monitoring site was exhausted at 52 records. Sample sizes for the outpatient observation and ED monitoring sites were 57 and 58 records respectively. The sample sizes for each monitoring area provided an 80% or higher chance of detecting differences of 20% between units when performing Chi-square analyses. Power for any of the parametric tests performed were greater than 90% for detecting differences of moderate size (ES = 0.29).

Permission to conduct this study was obtained through the Institutional Review Boards (IRBs) in the Clinical Research Department at the study site and from the University of Texas Health Science Center San Antonio (UTHSCSA). This research involved the retrospective review of existing patient data and level of care cost data stored in several computer databases and patient medical records. The information obtained was recorded in such a manner that the subjects could not be identified directly or through identifiers linked to the subjects. Data from this study was reported only as aggregate data. This study met the qualification for an "Exempt Review" by the IRBs at the study site and UTHSCSA.

Retrospective data collection had advantages and disadvantages. One advantage to this method of data collection was that existing records were used therefore the cost of conducting

the study was greatly reduced. Another advantage was that patients and hospital staff were not aware of their status as study participants and therefore could not distort their behavior. A disadvantage to retrospective data collection was that existing records might not represent the total population of possible study participants. Finally, because the researcher was not responsible for the accumulation of the data, the possibility of incompleteness in some of the stored data could not be controlled (Polit & Hungler, 1999). Therefore, although retrospective data collection was advantageous, it could not be undertaken without attention given to its potential problems.

Data Collection

Data was collected through retrospective record review of patients over 30 years of age and discharged between November 1, 1998 and April 30, 1999. The International Category of Diagnosis, 9th edition (ICD-9) codes were used to identify the records of patients who were monitored for chest pain (78650, 78659, 4100, 41001, 41002, 4101 - 4109, and 41200) and discharged between November 1, 1998 and April 30, 1999.

The Corporate Executive Information System (CEIS) database was used to obtain a printout of the patient population who were monitored for chest pain and released between November 1, 1998 and April 30, 1999. The data were extracted from CEIS by ICD-9 code (78650, 78659, 4100, 41001, 41002, 4101 - 4109, and 41200); medical record number (to capture inpatients); patient identification number (FMP and social security number, to capture outpatients); Medical Expense Performance and Reporting System (MEPRS) codes BIAA (ED), BACA (outpatient cardiology visits), and AABA (inpatient cardiology) to capture site of care; discharge date; and date of birth (DOB). ED discharge codes were used as an additional qualifier to identify those patients with the BIAA MEPRS code who were evaluated in and released from the ED only. Age was calculated by subtracting DOB from discharge date; data for patients under 30 years of age were eliminated.

The data obtained from CEIS were sorted by monitoring site and separated into four 6-week segments. A printout of the data sorted in this manner was distributed to outpatient and inpatient records personnel. Patient records were selected starting at the top of each 6-week segment printout for each monitoring site and continued until the records listed on the printout were exhausted or until 15 records were selected, whichever occurred first.

The following data were collected from the patient records: date and time of arrival to monitoring site; date and time of release from monitoring site; date and time of arrival to ED (for patients transferred to outpatient observation or inpatient cardiology monitoring sites only); gender, height, weight, and race; types of co-morbidities; physician specialty for initial ED evaluation; type of consultation; continuous telemetry monitoring; and the number of electrocardiograms, chest x-rays, stress tests, cardiac catheterizations, and echocardiograms. Length of stay (LOS) was determined by:

LOS = Date / Time of Release - Date/Time of Arrival

Height and weight data were used to determine the BMI for each patient (Kushner, 1993):

BMI = Weight in kilograms / (Height in centimeters / 100)^2

Data pertaining to TRICARE enrollment status, return visits within 30 days and return visit diagnosis were obtained for each monitoring site from the CEIS database. CEIS was also queried to determine if the return visit resulted in an inpatient admission. The Composite Health Care System (CHCS) was used to extract data regarding the number and type of laboratory tests performed, and the results of the CK-MB and Troponin I tests, for each sample patient.

Analysis of the Reynolds and Gaspari (1985) cost factors revealed that the pertinent costs to be analyzed for this study included: nursing staff costs, consultant fees, and diagnostic testing costs. Duty schedules from November 1, 1998 through April 30, 1999 were reviewed to determine the number of RNs, UAPs, and administrative personnel who actually worked in each monitoring site during each 6-week sampling period. The researcher created an EXCEL™ database to record and calculate all nursing staff cost data for this study. The monthly salary

costs obtained from the MEPRS Grade/Salary Table for fiscal year 1999 were used to determine the following cost data for each 6-week sampling period for each monitoring site: total daily salary costs, total salary costs per minute of service (MOS), and total salary costs for the 6-month data collection period. Total daily salary costs were determined by dividing monthly salary costs by 30.166 (the average number of days per month for the 6-month data collection period). Daily salary costs were divided by 1,440 (number of minutes in 24 hrs.) to determine the salary cost per MOS. An average salary cost per MOS for each monitoring site was determined and then multiplied by the number of minutes each patient was monitored to determine the average cost of nursing care per patient. Appendix A shows the monthly, daily, minute of service, and total salary costs for each 6-week segment of the sampling period, and the total nursing staff costs for each monitoring site. No salary increases were incorporated into this data.

Fiscal year 1999 International Military Education and Training (IMET) laboratory, radiology, and cardiology procedure rates issued by the Office of the Under Secretary of Defense (1998) were used by all military MTFs to determine diagnostic testing costs and were used as the basis for diagnostic testing costs in this study. Diagnostic testing costs were determined by multiplying the cost of each test by the total number of each of the tests conducted for each patient. The IMET rate for continuous telemetry monitoring procedure rates assume a full 24-hour stay. To determine the continuous telemetry monitoring cost for each patient, the 24-hour procedure rate was divided by 1,440 minutes (total minutes in 24 hrs.) to determine a cost per minute. The telemetry monitoring cost per minute was then multiplied by each patient's length of stay (in minutes). The process for determining continuous telemetry monitoring costs is depicted below:

COST = [(24-hour telemetry monitoring rate) / 1,440 minutes] x patient's length of stay

Therefore, the cost of telemetry monitoring was directly related to the patient's length of stay. An average continuous telemetry monitoring cost per patient (CPP) was determined for each monitoring site.

Fiscal year 1999 IMET outpatient visit rates for cardiology and internal medicine clinics issued by the Office of the Under Secretary of Defense (1998) were used as the basis for the internal medicine and cardiology consultant costs in this study. An average consultant cost per patient (CPP) was determined for each monitoring site.

The cost of each patient's chest pain care was the sum total of that patient's cost of nursing care, total diagnostic testing costs, continuous telemetry monitoring costs, and consultant costs. The total cost of chest pain care for each monitoring site was:

COST = Sum total of each individual patient's cost of chest pain care for each monitoring site.

The average cost per patient (CPP) for each monitoring site was:

COST = Total cost of chest pain care for each monitoring site / # of patients monitored

The data for this study were collected with the assistance of the decision support office, the coding office, medical records, and the business operations office at the study site. The decision support, coding, and business operations personnel had security access to the Corporate Executive Information System (CEIS), Composite Health Care System (CHCS), and Medical Expense and Performance Reporting System (MEPRS) computer databases that were used to extract data and they were knowledgeable regarding the functions of these database systems. The medical records personnel had security access to the medical records of patients monitored in the ED, outpatient observation unit, and inpatient cardiology unit and obtained the records for the sample patients. The researcher created an EXCEL™ database and all data for this study were recorded in this database. Diagnostic testing and consultant costs were also recorded in this database.

Data Analysis

The EXCEL™ database used for data collection was exported to the Statistical Package for the Social Sciences V10.0 (SPSS, 1999). SPSS (1999) was used to analyze the data. The probability of 0.05 was used for all statistical analyses. Chi-square analysis was used to test for

equivalence in the demographic data and the distribution of nursing staff among the 6-week sampling periods within each monitoring site. Chi-square analysis was used to test for differences among the three monitoring sites for: primary discharge diagnosis, percent recidivism, inpatient return visits, demographic characteristics (gender, race, TRICARE enrollment status, BMIs for overweight [30kg/cm^2] and obese [>35kg/cm^2] patients) and co-morbidities. Chi-square analysis was also used to evaluate differences in patients' placement on either the outpatient observation or inpatient cardiology units based on number of co-morbidities and physician specialty (i.e., internal medicine or cardiology). Differences in the number of diagnostic tests among the monitoring sites, and differences in the number and type of diagnostic tests between the outpatient observation unit and the inpatient cardiology unit were performed using Chi-square analysis. Chi-square analysis was also used to test for differences in the BMIs between males and females in the total sample, and between males and females in the ED only.

One-way ANOVA was used to compare the differences among the monitoring sites on the following variables: age, length of stay, differences in the number of diagnostic tests between the outpatient observation and inpatient cardiology units, and age of patients based on TRICARE enrollment status. A one-way ANOVA allows a test for differences among two or more sample mean scores (Munro, 1997). Significant ANOVAs were further analyzed using Tukey's Honestly Significant Difference (HSD) post-hoc test to determine which monitoring site was significantly different from the other two sites of care (Munro).

Two-way ANOVA was used to determine differences in length of stay based on TRICARE enrollment status among the monitoring sites. A two-way ANOVA allows testing for interactions when there is more than one independent (explanatory) variable (Munro, 1997).

The Reynolds and Gaspari (1985) cost-analysis framework was used to analyze the cost data (nursing staff for length of stay, consultant, and diagnostic testing) for each of the three alternatives for monitoring patients with chest pain (ED, outpatient observation, and inpatient

cardiology). The absolute and relative differences among the alternatives were determined. To determine the absolute difference in costs using the Reynolds and Gaspari cost-analysis framework "a value of zero (0) [was assigned] to the lowest cost line item and then the difference for the other alternatives [was] calculated" (p. C-3). Any significance in the differences in costs was determined by computing their relative differences. Relative differences in costs were computed by "taking the actual cost item [alternative] marked zero (0) and dividing it into figures shown for the remaining alternatives and multiplying that quotient by 100" (Reynolds & Gaspari, p. C-4).

Chapter Summary

The purpose of this retrospective, descriptive study was to compare the nursing and diagnostic testing costs, length of stay, actual incidence of an MI, and recidivism rate of three alternatives for monitoring patients who came to an emergency department complaining of chest pain. This study also compared the number and type of diagnostic tests ordered to rule-out MI by physician specialty, the effect of TRICARE enrollment status on length of stay, and demographic and co-morbidity differences between patients diagnosed with MI and those ruled-out for MI among the three alternative delivery care sites for monitoring patients with chest pain.

The terms relevant to this study were operationally defined. The setting for this study described the three alternative sites for monitoring patients in a military treatment facility in the Southwest United States. A sample of 167 patients were included in this study of patients who came to the ED with chest pain and were discharged between November 1,1998 and April 30, 1999. Data were collected retrospectively from a variety of computer database systems and patients' medical records with the assistance of the decision support, coding, and medical records offices at the study site. Cost data was also collected retrospectively with the assistance of the business operations office at the study site. The plans for the analysis of the data were described. The findings of the study will be reported in Chapter IV.

IV. ANALYSIS AND INTERPRETATION OF DATA

This study investigated the costs, patient outcomes of actual diagnosis of MI and recidivism rate, of three alternatives for monitoring patients with chest pain. In addition this study investigated differences in (a) diagnostic testing by physician specialty, (b) co-morbidities and demographic characteristics for patients who ruled-in for an MI and ruled-out for an MI, and (c) TRICARE enrollment status and length of stay, among the three alternative care sites for monitoring patients with chest pain. The explanatory (independent) variable in this study was the unit that monitored the patient with chest pain (ED, outpatient observation unit, or inpatient cardiology unit). The outcome (dependent) variables were: (a) the nursing care and patient monitoring costs (diagnostic testing, consultant fees), (b) the percent of monitored patients diagnosed with MI, (c) the percent of monitored patients who returned with a complaint of chest pain within 30 days of release, (d) the length of stay for patients monitored for chest pain, (e) the type and number of diagnostic tests ordered to rule-out MI by physician specialty, (f) the length of stay for TRICARE and non-TRICARE patients, and, (g) the differences in demographic characteristics and the number of co-morbidities in patients diagnosed with an MI and patients ruled-out for an MI. Costs were determined by using nursing staff salaries, diagnostic testing, consultant fees, and length of stay for each of the monitoring sites.

This chapter provides the results of statistical analyses of differences in the outcome variables among the monitoring sites. The research questions for this study included, for patients monitored for chest pain in the ED, outpatient observation unit, and inpatient cardiology unit:

1. What are the differences in length of stay?
2. What are the differences in costs for nursing staff, diagnostic testing, consultant, and length of stay?
3. What is the difference in percent of patients who present with chest pain and who are ultimately diagnosed with a myocardial infarction?

4. What are the differences in the recidivism rate for returning to the MTF within 30 days with the complaint of chest pain?
5. What are the differences in physician specialty and the type and number of diagnostic tests ordered to rule-out MI in patients?
6. What are the differences in length of stay for patients enrolled in TRICARE and not enrolled in TRICARE?
7. What are the differences in the demographic characteristics and co-morbidities of patients diagnosed with MI and patients ruled-out for MI?

Subject Characteristics

The sample consisted of 167 patients who were monitored for chest pain between November 1, 1998 and April 30, 1999 in one of three monitoring sites: ED (n=58), outpatient observation unit (n=57), and inpatient cardiology unit (n=52).

Chi-square analysis was used to compare the demographic data to determine if the 6-week sampling periods within each monitoring site were equivalent for gender, race, and TRICARE enrollment status. There were no significant differences among the 6-week sampling periods within each monitoring site for: (a) Gender (see Table 1), (b) race (see Table 2), and (c) TRICARE enrollment status (see Table 3).

Table 1

Gender Differences Within the Four 6-Week Sampling Periods For Each Monitoring Site

	MONITORING SITE											
GENDER	**ED**				**Outpatient Observation Unit**				**Inpatient Cardiology Unit**			
	6-Week Periods*				**6-Week Periods***				**6-Week Periods***			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Number of Males	9	4	4	6	8	8	5	10	7	8	12	9
Number of Females	6	11	11	7	7	7	8	4	4	4	3	5
Significance	χ^2=4.939, *df*=3, *p*=.176				χ^2=2.981, df=3, *p*=.394				χ^2=1.176, *df*=3, *p*=.759			

*Period 1: November 1, 1998-December 15, 1998; Period 2: December 16, 1998-January 31, 1999; Period 3: February 1, 1999-March 15, 1999; Period 4: March 16, 1999-April 30, 1999.

Table 2

Race Differences Within the Four 6-Week Sampling Periods For Each Monitoring Site

RACE	MONITORING SITE											
	ED				Outpatient Observation Unit				Inpatient Cardiology Unit			
	6-Week Periods*				6-Week Periods*				6-Week Periods*			
	1	2	3	4	1	2	3	4	1	2	3	4
Number of Caucasian Patients	11	8	11	9	12	13	7	9	6	5	10	10
Number of African-American Patients	1	4	0	1	0	1	1	0	0	3	2	1
Number of Hispanic Patients	1	3	3	1	2	1	2	1	4	3	2	3
Number of Asian Patients	1	0	0	0	0	0	0	1	0	0	0	0
Number of Patients with no Race Documented	1	0	2	1	2	2	1	2	0	1	1	1
Significance	χ^2=10.441, *df*=9, *p*=.316				χ^2=6.979, *df*=9, *p*=.639				χ^2=6.128, *df*=6, *p*=.409			

*Period 1: November 1, 1998-December 15, 1998; Period 2: December 16, 1998-January 31, 1999; Period 3: February 1, 1999-March 15, 1999; Period 4: March 16, 1999-April 30, 1999.

Table 3

Differences in TRICARE Enrollment Status Within the Four 6-Week Sampling Periods For Each Monitoring Site

ENROLLMENT STATUS	MONITORING SITE											
	ED				Outpatient Observation Unit				Inpatient Cardiology Unit			
	6-Week Periods*				6-Week Periods*				6-Week Periods*			
	1	2	3	4	1	2	3	4	1	2	3	4
Number of Enrolled Patients	11	11	13	7	9	11	9	11	3	8	10	6
Number of Non-enrolled Patients	1	1	0	3	2	2	1	0	0	1	1	2
Number of Not eligible for enrollment Patients	1	1	1	1	1	0	2	1	4	0	4	4
Number of Patients with Enrollment Status not Documented	2	1	3	1	3	1	2	2	2	2	3	2
Significance	χ^2=5.618, *df*=6, *p*=.467				χ^2=4.515, *df*=6, *p*=.607				χ^2=8.053, *df*=6, *p*=.234			

*Period 1: November 1, 1998-December 15, 1998; Period 2: December 16, 1998-January 31, 1999; Period 3: February 1, 1999-March 15, 1999; Period 4: March 16, 1999-April 30, 1999.

Multivariate analysis was used to compare the demographic data to determine if the 6-week sampling periods within each monitoring site were equivalent for age, height, and weight. There was no interaction effect for age (F=1.012, df=6, p=.422), height (F=.640, df=6, p=.698), or weight (F=1.127, df=6, p=.352) among the 6-week sampling periods within each monitoring site. Since Chi-square and multivariate analysis demonstrated that the 6-week sampling periods within each monitoring site were equivalent, further statistical analyses were used to compare differences among the monitoring sites only: ED, outpatient observation unit, and inpatient cardiology unit.

ANOVA was used to analyze differences in age (see Table 4). There were no significant differences in the mean patient ages (F=2.918, df=2, p=.057) among the monitoring sites.

Table 4

Differences in Mean Patient Age for Each Monitoring Site

				95% Confidence Interval for Mean			
MONITORING SITE	**Number of Patients**	**Mean Age of Patients**	**Std. Deviation**	**Lower Bound**	**Upper Bound**	**Minimum Age**	**Maximum Age**
ED	58	62 yr.	14.1175	58 yr.	65 yr.	31 yr.	86 yr.
Outpatient Observation	57	59 yr.	11.7434	56 yr.	62 yr.	39 yr.	80 yr.
Inpatient Cardiology	52	65 yr.	12.8963	62 yr.	69 yr.	38 yr.	89 yr.

Chi-square analysis was used to determine differences in gender, race, and TRICARE enrollment status. Analysis showed there were significant differences in gender among the monitoring sites (χ^2 = 9.660, df=2, p=.008). The ED had a larger percentage of females while the outpatient observation and inpatient cardiology units had a larger percentage of males (see Table 5).

Table 5

Differences in Gender Among the Monitoring Sites

	MONITORING SITE			
	ED	Outpatient Observation Unit	Inpatient Cardiology Unit	Total
GENDER	Number (%)	Number (%)	Number (%)	Number (%)
Males	23 (14%)	31 (18%)	36 (22%)	90 (54%)
Females	35 (21%)	26 (16%)	16 (9%)	77 (46%)
Total	58 (35%)	57 (34%)	52 (31%)	167 (100%)

There were no significant differences in race among the monitoring sites ($\chi^2 = 6.839$, *df*=6, *p*=.336) (see Table 6). Race was not documented in the records of 8% (N=14) of the patients, therefore race was analyzed for 92% (N=153) of the total sample of 167 patients.

Table 6

Differences in Race Among the Monitoring Sites

	MONITORING SITE			
	ED	Outpatient Observation Unit	Inpatient Cardiology Unit	Total
RACE	Number (%)	Number (%)	Number (%)	Number (%)
Caucasian	39 (25%)	41 (27%)	31 (20%)	111 (73%)
African-American	6 (4%)	2 (1%)	6 (4%)	14 (9%)
Hispanic	8 (5%)	6 (4%)	12 (8%)	26 (17%)
Asian	1 (1%)	1 (1%)	0 (0%)	2 (1%)
Total	54 (35%)	50 (33%)	49 (32%)	153* (100%)

*Race was not documented in the records of 8% (N=14) of the patients: ED, 2% (n=4); Outpatient Observation Unit, 4% (n=7); Inpatient Cardiology Unit, 2% (n=3)

Differences in TRICARE enrollment status were statistically significant ($\chi^2 = 9.998$, df=4, p=.040) with a trend toward more patients who were not eligible for enrollment cared for in the inpatient cardiology unit (8%, n=12) (see Table 7). TRICARE enrollment status was not documented in the records of 14% (N=24) of the patients, therefore TRICARE enrollment status was analyzed for 86% (N=143) of the total sample of 167 patients.

Table 7

Differences in TRICARE Enrollment Status Among the Monitoring Sites

	MONITORING SITE			
	ED	Outpatient Observation Unit	Inpatient Cardiology Unit	Total
TRICARE Status	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**
Enrolled	42 (29%)	40 (28%)	27 (18%)	109 (76%)
Not Enrolled	5 (4%)	5 (4%)	4 (3%)	14 (10%)
Not Eligible for Enrollment	4 (3%)	4 (3%)	12 (8%)	20 (14%)
Total	51 (36%)	49 (34%)	43 (29%)	143* (100%)

*TRICARE Enrollment Status was not documented in the records of 14% (N=24) of the patients: ED, 4% (n=7); Outpatient Observation Unit, 5% (n=8); Inpatient Cardiology Unit, 5% (n=9)

Chi-square analysis was used to determine if there were any differences in height and weight (expressed as BMI) among the monitoring sites, and between males and females. Mean weights for the patients in each monitoring site were: ED (*M*=82 kg), outpatient observation unit (*M*=83 kg), inpatient cardiology unit (*M*=91 kg). Mean heights for the patients in each monitoring site were: ED (*M*=165 cm), outpatient observation unit (*M*=165 cm), inpatient cardiology unit (*M*=168 cm). The BMI for each patient was determined by:

BMI = Weight in kilograms / (Height in centimeters / 100) ^{2}

Height and/or weight data were not documented in the records of 31% (N=52) of the patients, therefore BMIs could only be calculated for 69% (N=115) of the total sample of 167 patients. Of the 115 patients with a BMI of 30kg/cm^2 (overweight) analysis also showed no significant differences among monitoring sites (χ^2=.278, *df*=2, *p*=.870).

Table 8

Differences in Overweight BMI for Patients Among the Monitoring Sites

	MONITORING SITE			
	ED	Outpatient Observation Unit	Inpatient Cardiology Unit	Total
BMI	Number (%)	Number (%)	Number (%)	Number (%)
Overweight (30kg/cm²)	19 (17%)	11 (10%)	18 (16%)	48 (42%)
Not Overweight (<30kg/cm²)	28 (24%)	17 (15%)	22 (19%)	67 (%)
Total	47 (41%)	28 (24%)	40 (35%)	115* (100%)

* Height and/or Weight was not documented in the records of 31% (N=52) of the patients: ED, 6% (n=10); Outpatient Observation Unit, 18% (n=30); Inpatient Cardiology Unit, 7% (n=12).

There were no significant differences in the number of overweight males and overweight females (χ^2=1.253, *df*=1, *p*=.263) in the sample of 115 patients (see Table 9).

Table 9

Differences in Overweight BMI Between Males and Females

	Male	Female	Total
BMI	Number (%)	Number (%)	Number (%)
Overweight (30kg/cm²)	28 (24%)	20 (17%)	48 (42%)
Not Overweight (<30kg/cm²)	32 (28%)	35 (30%)	67 (58%)
Total	60 (52%)	55 (47%)	115 (100%)

* Height and/or Weight was not documented in the records of 31% (N=52) of the patients: ED, 6% (n=10); Outpatient Observation Unit, 18% (n=30); Inpatient Cardiology Unit, 7% (n=12).

Of the 115 patients with a BMI greater than 35 kg/cm² (obese) analysis showed no significant differences among monitoring sites (χ^2=4.189, *df*=2, *p*=.123) (see Table 10).

Table 10

Differences in Obese BMI for Patients Among the Monitoring Sites

	MONITORING SITE			
	ED	Outpatient Observation Unit	Inpatient Cardiology Unit	Total
BMI	Number (%)	Number (%)	Number (%)	Number (%)
Obese (>35kg/cm²)	5 (4%)	3 (3%)	10 (9%)	18 (16%)
Not Obese (<35kg/cm²)	42 (36%)	25 (22%)	30 (26%)	97 (84%)
Total	47 (40%)	28 (25%)	40 (35%)	115 (100%)

* Height and/or Weight was not documented in the records of 31% (N=52) of the patients: ED, 6% (n=10); Outpatient Observation Unit, 18% (n=30); Inpatient Cardiology Unit, 7% (n=12).

There were no significant differences in the number of obese males and obese females (χ^2=.752, *df*=1, *p*=.386) in the sample of 115 patients (see Table 11).

Table 11

Differences in Obese BMI Between Males and Females

	Male	Female	Total
BMI	Number (%)	Number (%)	Number (%)
Obese (>35kg/cm²)	11 (9%)	7 (6%)	18 (16%)
Not Overweight (<35kg/cm²)	49 (43%)	48 (42%)	97 (84%)
Total	60 (52%)	55 (48%)	115 (100%)
Height and/or Weight Not Documented	30 (18%)	22 (13%)	52 (31%)

*Height and/or Weight was not documented in the records of 31% (N=52) of the patients: Male, 18% (N=30); Female, 13% (N=22)

Further statistical analyses of the data will be presented in relation to the research questions.

Question 1

To analyze the first research question, what are the differences in length of stay for patients monitored for chest pain in the ED, outpatient observation unit, and inpatient cardiology unit, an ANOVA was used (see Table 12). Post-hoc analysis to determine which monitoring site had a significantly different length of stay from the other two sites was done using Tukey's HSD.

Table 12

Differences in Mean Length of Stay Among the Monitoring Sites

	MONITORING SITE		
	ED	**Outpatient Observation Unit**	**Inpatient Cardiology Unit**
Mean Length of Stay	197 minutes (3 hrs. 17 min.)	1,110 minutes (18 hrs. 20 min.)	3,161 minutes (52 hr. 41 min.)

Initial post-hoc analysis using Tukey's HSD showed significant differences in the mean length of stay between the ED and the inpatient cardiology monitoring sites, and between the outpatient observation and the inpatient monitoring sites (F=14.729, df=2, p=.000). There were no significant differences (p=.218) in the mean length of stay between the outpatient observation and ED monitoring sites.

However, within the inpatient cardiology monitoring site two outliers in length of stay were noted: 14,180 min. (9.8 days) and 35,719 min. (24.8 days). Munro (1997) suggests that the traditional method of labeling outliers has been to locate values that are more than 3 standard deviations (SDs) from the mean (see Figure 1).

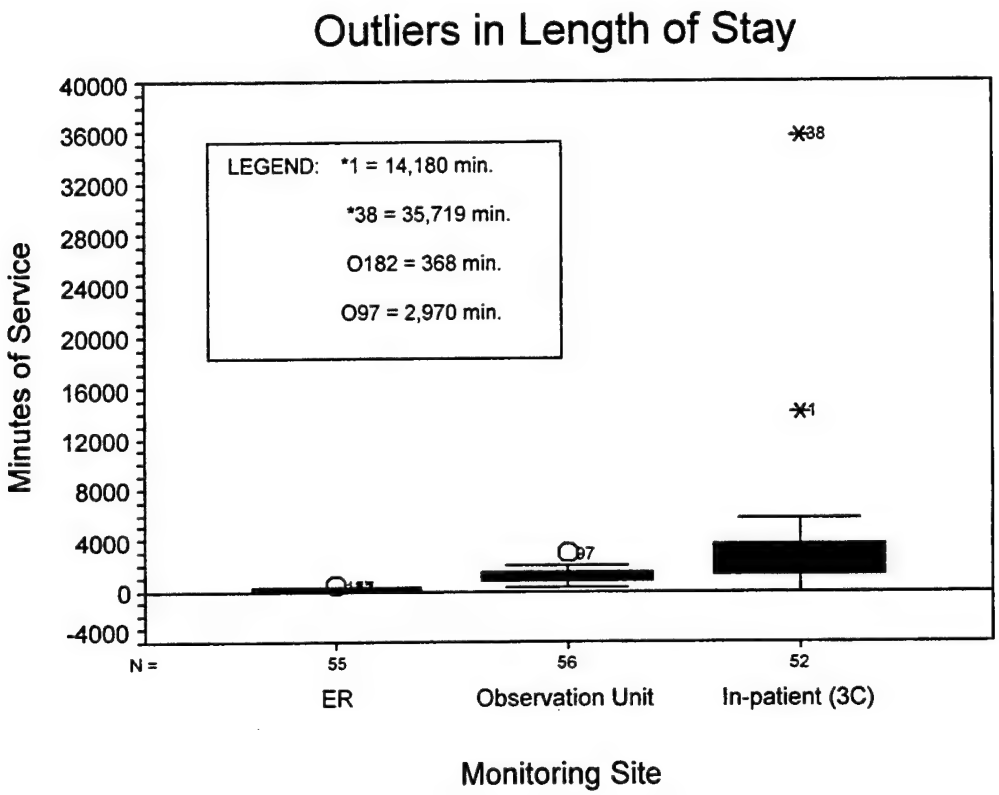

Figure 1. Stem and Leaf Plot graph shows the outliers for length of stay in all three monitoring sites. The outliers for the inpatient cardiology monitoring site were more than 3 SDs from the mean and were removed from cost, diagnostic testing and length of stay analyses.

Since mean is a measure of central tendency it can be very susceptible to outliers (Munro). Munro recommends that data be analyzed two ways: with the outliers included and with the outliers removed. The ANOVA was re-run and this second analysis showed significant differences among all of the monitoring sites: ED and outpatient observation, ED and inpatient cardiology, outpatient observation and inpatient cardiology (F=81.538, df=2, p=.000) (see Table 13).

Table 13

Differences in Mean Length of Stay Among the Monitoring Sites after Outliers Removed

	MONITORING SITE		
	ED	**Outpatient Observation Unit**	**Inpatient Cardiology Unit**
Mean Length of Stay	197 minutes (3 hrs. 17 min.)	1,110 minutes (18 hrs. 20 min.)	2,289 (38hr. 9 min.)

The outliers in length of stay did increase the variability of the analysis and were removed from all further cost, diagnostic testing, and length of stay analyses.

ANOVA was also used to determine if there were any significant differences in the mean length of stay in the ED for patients placed in the outpatient observation unit and the inpatient cardiology unit (see Table 14).

Table 14

Differences in the Mean ED Length of Stay for Patients Placed in the Outpatient Observation Unit and the Inpatient Cardiology Unit

					95% Confidence Interval for Mean	
Monitoring Site	**Number Of Patients**	**Mean Length of Stay**	**Std. Deviation**	**Std. Error**	**Length of Stay (Lower Bound)**	**Length of Stay (Upper Bound)**
Outpatient Observation	47	257 min.	86	12	232 min.	282 min.
Inpatient Cardiology	43	470 min.	886	135	197 min.	743 min.

Analysis revealed no significant differences (F=2.683, df=1, p=.105) in the mean ED length of stay for patients placed in the outpatient observation unit (M=257 min. [4 hr. 17 min.]) or the inpatient cardiology unit (M=470 min. [7 hr. 50 min.]).

Question 2

To analyze the second question, what are the differences in costs for nursing staff, diagnostic testing, consultant, and LOS, for patients monitored for chest pain in the ED,

outpatient observation unit, and inpatient cardiology unit, cost analysis (Reynolds & Gaspari, 1985) was used.

The Reynolds and Gaspari (1985) cost analysis framework was used to determine absolute differences in nursing staff costs and cost per LOS, diagnostic testing costs, and consultant costs. The significance in the differences in costs was determined by calculating relative differences. To determine the actual number of nursing staff assigned to each of the monitoring sites the duty schedules from November 1, 1998 through April 30, 1999 were reviewed. The number of RNs, UAPs, and administrative personnel who actually worked in each monitoring site were collected for each 6-week sampling period. Chi-square analysis was used to determine if there were any differences in the distribution of nursing staff among the 6-week sampling periods within each monitoring site. Analysis revealed no significant differences in the distribution of nursing staff within each monitoring site: ED (χ^2 =.358, df=6, p=.999); outpatient observation unit (χ^2 =.063, df=6, p=1.000); inpatient cardiology unit (χ^2 =.229, df=6, p=.1.000). Therefore, this cost analysis compared differences among the monitoring sites only.

The monthly salary costs obtained from the MEPRS Grade/Salary Table for fiscal year 1999 were used to determine the following cost data for each monitoring site: total daily salary costs, total salary costs per minute of service (MOS), and total salary costs for the 6-month data collection period. The researcher created an EXCEL™ database to record and calculate all nursing staff cost data for this study. Appendix A shows the monthly, daily, minute of service, and total salary costs for each monitoring site.

An average cost per MOS for nursing care was determined for each monitoring site. The inpatient cardiology unit had the lowest average cost per MOS for nursing care. These costs represent the nursing cost per MOS for monitoring all patients on each unit, not just patients with chest pain. The average cost per MOS was multiplied by the number of minutes each patient was monitored to determine the average cost of nursing care per patient. Table 15,

shows the average cost per MOS for nursing care among the monitoring sites, the absolute differences in costs, and the relative per MOS costs.

Table 15

Average Cost per MOS for Nursing Care, Absolute Differences in Costs, Relative Costs for Each Monitoring Site

	MONITORING SITES		
COSTS	**ED**	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE COST per MOS	$0.0949	$0.0877	$0.0856
ABSOULTE DIFFERENCES IN COSTS	$0.0093	$0.0021	$0
RELATIVE COSTS (%)	11%	2%	0%

Diagnostic testing costs included the costs of all laboratory testing and procedures for patients with chest pain: CK-MB ($11.45), Troponin-I ($8.90) complete blood count ($6.61), basic chemistry panel ($8.27), comprehensive chemistry panel ($8.90), prothrombin/partial thrombin time ($9.54), liver function test ($7.63), lactic-dehydrogenase ($12.72), lipid panel ($17.81), arterial blood gas ($19.08), amylase ($6.36), and lipase ($7.00), chest x-rays ($18.75), electrocardiograms ($13.60), stress tests ($55.25), cardiac catheterizations ($772.99), and echocardiograms ($168.47). The ED had the lowest average diagnostic testing cost per patient (CPP). Table 16, shows the average diagnostic testing CPP for each of the monitoring sites, the absolute differences in costs, and the relative costs for diagnostic testing. Table 17, shows the differences in the absolute differences in costs and the relative diagnostic testing costs for the outpatient observation unit and the inpatient cardiology unit.

Table 16

Average Diagnostic Testing CPP, Absolute Differences in Costs, Relative Costs for Each Monitoring Site

	MONITORING SITES		
COST PER PATIENT	**ED**	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE DIAGNOSTIC TESTING	$50	$153	$422
ABSOLUTE DIFFERENCES IN COSTS	$0	$103	$372
RELATIVE COSTS (%)	0%	206%	744%

Table 17

Absolute Differences in Costs and Relative Diagnostic Testing CPP for the Outpatient Observation Unit and the Inpatient Cardiology Unit

	MONITORING SITES	
COST PER PATIENT	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE DIAGNOSTIC TESTING	$153	$422
ABSOLUTE DIFFERENCES IN COSTS	$0	$269
RELATIVE COSTS (%)	0%	176%

Continuous telemetry monitoring costs were analyzed separately from the other diagnostic testing costs. Continuous telemetry monitoring costs were determined by dividing the 24-hr. telemetry monitoring rate ($79.22) by 1,440 minutes (to determine the telemetry monitoring cost per min.) and then multiplying by the patients' total LOS in minutes. The ED had the lowest average continuous telemetry monitoring cost per patient (CPP). Table 18, shows for the patients with chest pain the average continuous telemetry monitoring CPP for each of the three monitoring sites, the absolute differences in costs, and the relative costs for telemetry monitoring. Table 19, shows the absolute differences in costs and the relative continuous telemetry monitoring CPP for the outpatient observation unit and the inpatient cardiology unit.

Table 18

Average Continuous Telemetry Monitoring CPP, Absolute Differences in Costs, Relative Costs for Each Monitoring Site

	MONITORING SITES		
COST PER PATIENT	**ED**	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE CONTINUOUS TELEMETRY MONITORING	$10	$54	$126
ABSOLUTE DIFFERENCES IN COSTS	$0	$44	$116
RELATIVE COSTS (%)	0%	440%	1160%

Table 19

Absolute Differences in Costs and Relative Continuous Telemetry Monitoring CPP for Outpatient Observation Unit and Inpatient Cardiology Unit

	MONITORING SITES	
COST PER PATIENT	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE CONTINUOUS TELEMETRY MONITORING	$54	$126
ABSOLUTE DIFFERENCES IN COSTS	$0	$72
RELATIVE COSTS (%)	0%	133%

Consultant costs consisted of the cost of a clinic visit for either the internal medicine specialty ($104) or the cardiology specialty ($78). The ED had the lowest average consultant cost per patient (CPP). Table 20, shows the average consultant CPP for each of the three monitoring sites, the absolute differences in costs, and the relative consultant costs. Table 21, shows the absolute differences in costs and the relative consultant CPP for the outpatient observation unit and the inpatient cardiology unit.

Table 20

Average Consultant CPP, Absolute Differences in Costs, Relative Costs for Each Monitoring Site

	MONITORING SITES		
COST PER PATIENT	**ED**	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE CONSULTANT CPP	$3	$61	$82
ABSOLUTE DIFFERENCES IN COSTS	$0	$58	$79
RELATIVE COSTS (%)	0%	1,933%	2,633%

Table 21

Absolute Differences in Costs and Relative Consultant CPP for the Outpatient Observation Unit and Inpatient Cardiology Unit

	MONITORING SITES	
COST PER PATIENT	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE CONSULTANT CPP	$61	$82
ABSOLUTE DIFFERENCES IN COSTS	$0	$21
RELATIVE COSTS (%)	0%	34%

The total cost of caring for patients with chest pain in each monitoring site was the sum total of the patients' cost of nursing care, diagnostic testing costs, continuous telemetry monitoring costs, and consultant costs. The average cost per patient (CPP) for patients with chest pain in each monitoring site was determined by:

COST = Total cost of chest pain care in each monitoring site / # of patients monitored in each site

For patients placed in the outpatient observation or inpatient cardiology monitoring sites, the cost of the time spent in the ED was also included in the determination of the average CPP. Table 22 shows the average CPP for each monitoring site, the absolute differences in costs, and the relative average CPP excluding time spent in the ED (for the outpatient observation and inpatient cardiology monitoring sites). Table 23 shows the average CPP for each monitoring site, the absolute differences in costs, and the relative average CPP including time spent in the ED (for the outpatient observation and inpatient cardiology monitoring sites). The ED had the lowest average CPP.

Table 22

Average CPP, Absolute Differences in Costs, and Relative Costs for Each Monitoring Site (Excluding Time Spent in ED for the Outpatient Observation and Inpatient Cardiology Monitoring Sites

	MONITORING SITES		
COSTS	**ED**	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE CHEST PAIN CARE CPP	$63	$364	$826
ABSOLUTE DIFFERENCES IN COSTS	$0	$301	$763
RELATIVE COSTS (%)	0%	478%	1211%

Table 23

Absolute Differences in Costs and Relative Average CPP for the Outpatient Observation and Inpatient Monitoring Sites (Including Time Spent in the ED)

	MONITORING SITES	
COSTS	**OUTPATIENT OBSERVATION**	**INPATIENT CARDIOLOGY**
AVERAGE CHEST PAIN CARE CPP	$400	$864
ABSOLUTE DIFFERENCES IN COSTS	$0	$464
RELATIVE COSTS (%)	0%	116%

Question 3

To analyze the third question, what is the difference in percent of patients who present with chest pain and who are ultimately diagnosed with an MI in the ED, outpatient observation unit, and inpatient cardiology unit, statistical analyses was used to analyze the differences in primary diagnosis among the monitoring sites.

From the sample of 167 patients, only 1.2% (N=2) of the patients were diagnosed with MI. Both diagnosed cases of MI occurred within the inpatient cardiology unit sample of patients. Chi-square analysis was used, however, to determine if there were significant differences among the monitoring sites for primary discharge diagnosis (see Table 24). The distribution of cardiac and non-cardiac chest pain discharge diagnoses were significantly differently (χ^2= 34.464, *df*=2, *p*=.000) among the monitoring sites.

Table 24

Differences in Primary Discharge Diagnoses Among the Monitoring Sites

	MONITORING SITES		
DISCHARGE DIAGNOSIS	**Number (%) ED**	**Number (%) Outpatient Observation**	**Number (%) Inpatient Cardiology**
Cardiac Chest Pain	31 (53%)	2 (4%)	19 (37%)
Non-Cardiac Chest Pain	27 (47%)	55 (96%)	33 (63%)

Question 4

To analyze the fourth question, what are the differences in the recidivism rate for returning to the MTF within 30 days with the complaint of chest pain for patients monitored in the ED, outpatient observation unit, and inpatient cardiology unit, Chi-square analysis was used.

Analysis showed there were no significant differences in recidivism rates for patients with chest pain among the monitoring sites ($\chi^2 = .507$, $df=4$, $p=.973$) (see Table 25). Of the patients who returned with a complaint of chest pain only one was subsequently diagnosed with an MI. This person was originally monitored in the ED.

Table 25

Recidivism Rates for Each Monitoring Site

	MONITORING SITE			
	ED	**Outpatient Observation Unit**	**Inpatient Cardiology Unit**	**Total**
Total Revisits = 0 **% Revisits**	45 78%	43 75%	41 79%	129 77%
Total Revisits = 1 **% Revisits**	9 16%	11 19%	8 15%	28 17%
Total Revisits = 2+ **% Revisits**	4 7%	3 5%	3 6%	10 6%

Question 5

The fifth question, what are the differences in physician specialty and the type and number of diagnostic tests ordered to rule out MI in patients monitored for chest pain in the ED, outpatient observation unit, and inpatient cardiology unit, could not be answered. Physician specialty for patients with chest pain only varied on initial evaluation in the ED. Ninety-seven percent of the patients evaluated in and released from the ED saw only ED physicians. Patients who were placed on the outpatient observation or inpatient cardiology units were initially evaluated in the ED by either an internal medicine or cardiology resident depending on the time of day and day

of week. Once these patients were placed in the outpatient observation or inpatient cardiology units they were followed by the cardiology service.

The ED had an operating instruction (OI) that directed the initial management of patients with chest pain. Initial management of patients with chest pain in the ED included continuous telemetry monitoring, electrocardiogram, 30 cubic centimeters (cc) of blood "to hold". The outpatient observation unit used a protocol to rule-out MI in patients with chest pain. This protocol included 3 sets of CK-MB and Troponin-I cardiac enzyme tests, 2 electrocardiograms (1 on arrival to the unit and 1 when the cardiac enzyme tests were complete), continuous telemetry monitoring, and nothing by mouth in preparation for possible stress testing (usually done the morning after admission). The inpatient cardiology unit did not use a protocol for patients with chest pain.

In this study only the differences in the type and number of diagnostic tests among the units was examined. Chi-square analysis was used to determine if there were any significant differences in the number of diagnostic tests. In the ED the diagnostic testing ranged from 2 to 9 tests, with 49% (n=27) of the patients having only 2 diagnostic tests. In the outpatient observation unit diagnostic testing ranged from 7 to 17 tests, with 38% (n=22) of the patients having between 10 to 11 tests. In the inpatient cardiology unit diagnostic testing ranged from 12 to 26 tests, with 44% (n=22) of the patients having between 13 to 16 tests. Analysis showed significant differences (χ^2=188.950, *df*=42, *p*=.000) in the number of diagnostics tests among the units. One-way ANOVA was used to determine if there were any significant differences in the number of tests on the outpatient observation unit and the inpatient cardiology unit. Post-hoc analysis was done using Tukey's HSD. Analysis showed significant differences (*F*=37.451, *df*=1, *p*=.000) between these two units, with patients in the outpatient observation unit having an average of 11 (SD ± 3) diagnostic tests and the patients on the inpatient cardiology unit having an average of 15 tests (SD ± 4). Chi-square analysis further showed that in the inpatient cardiology unit significantly more chest x-rays, cardiac catheterizations, echocardiograms, and

CBC tests were conducted than in the outpatient observation unit. In the outpatient observation unit significantly more stress tests were conducted than in the inpatient cardiology unit (See Table 26).

Table 26

Significant Differences in Number and Type of Diagnostic Tests Between the Outpatient Observation Unit and the Inpatient Cardiology Unit

TEST	MONITORING SITE	
	OUTPATIENT OBSERVATION UNIT (n=57)	INPATIENT CARDIOLOGY UNIT (n=50)
Chest X-Rays (χ^2 = 12.226, *df*=1, *p*=.000)	2 (4%)	15 (30%)
Cardiac Catheterizations (χ^2 = 12.226, *df*=1, *p*=.000)	2 (4%)	15 (30%)
Echocardiograms (χ^2= 12.591, *df*=1, *p*=.000)	0 (0%)	11 (22%)
CBC (χ^2= 25.058, *df*=5, *p*=.000)	11 (22%)	32 (64%)
Stress Tests (χ^2= 11.115, *df*=1, *p*=.001)	43 (81%)	25 (50%)

The number of electrocardiograms were significantly different (χ^2= 13.963, *df*=5, *p*=.016) with 3 or more electrocardiograms per patient performed more often in the inpatient cardiology unit. The number of CHEM10 tests were significantly different (χ^2= 19.379, *df*=6, *p*=.004) with 2 or more CHEM10 tests performed in the inpatient cardiology unit.

There were no significant differences between the two monitoring sites for the number of the following laboratory tests: CK-MB, Troponin I, CHEM7, PT/PTT, liver function test (LFT), lactic dehydrogenase (LDH), lipid panel, arterial blood gas (ABG), amylase, and lipase (See Table 27).

Table 27

Non-significant Differences in the Number of Laboratory Tests for Patients in the Outpatient Observation Unit and the Inpatient Cardiology Unit

TEST	MONITORING SITE	
	OUTPATIENT OBSERVATION UNIT (n=57)	INPATIENT CARDIOLOGY UNIT (n=50)
CK-MB (χ^2=5.090, *df*=4, *p*=.278)	114	113
Troponin-I (χ^2=9.040, *df*=4, *p*=.060)	116	113
CHEM 7 (χ^2=.371, *df*=1, *p*=.542)	2	3
PT/PTT (χ^2=8.423, *df*=4, *p*=.077)	5	21
Liver Function Test (LFT) (χ^2=3.968, *df*=3, *p*=.265)	10	13
Lactic Dehydrogenase (LDH) (χ^2=4.737, *df*=2, *p*=.094)	0	5
Lipid Panel (χ^2=2.687, *df*=2, *p*=.261)	19	13
Arterial Blood Gas (ABG) (χ^2=2.922, *df*=2, *p*=.232)	8	5
Amylase (χ^2=2.054,*df*=2,*p*=.358)	8	6
Lipase (χ^2=.529,*df*=1,*p*=.467)	7	4

Continuous telemetry monitoring was constant between the two monitoring sites.

Question 6

To answer the sixth question, what are the differences in length of stay for patients enrolled in TRICARE and not enrolled in TRICARE who were monitored for chest pain in the ED, outpatient observation unit, and inpatient cardiology unit, a two-way ANOVA was used. Post-hoc analysis was done using Tukey's HSD. The three monitoring sites differed for LOS (p=.000). TRICARE enrollment status did not differ among the monitoring sites (p=.617). There was no interaction between monitoring site and enrollment status in relation to LOS (p=.964) (see Figure 2). There was a trend, however, for longer length of stay for patients not eligible for enrollment within all three monitoring sites (see Table 28).

Table 28

Length of Stay and Enrollment Status for Patients in Each Monitoring Site

Monitoring Site	TRICARE Enrollment	Mean Min.	Number (N) of Patients
ED	Enrolled	199	39
	Not enrolled	165	5
	Not eligible for enrollment	207	4
Outpatient Observation Unit	Enrolled	1,113	39
	Not enrolled	930	5
	Not eligible for enrollment	1,150	4
Inpatient Cardiology Unit	Enrolled	2,158	27
	Not enrolled	1,699	4
	Not eligible for enrollment	2,071	11

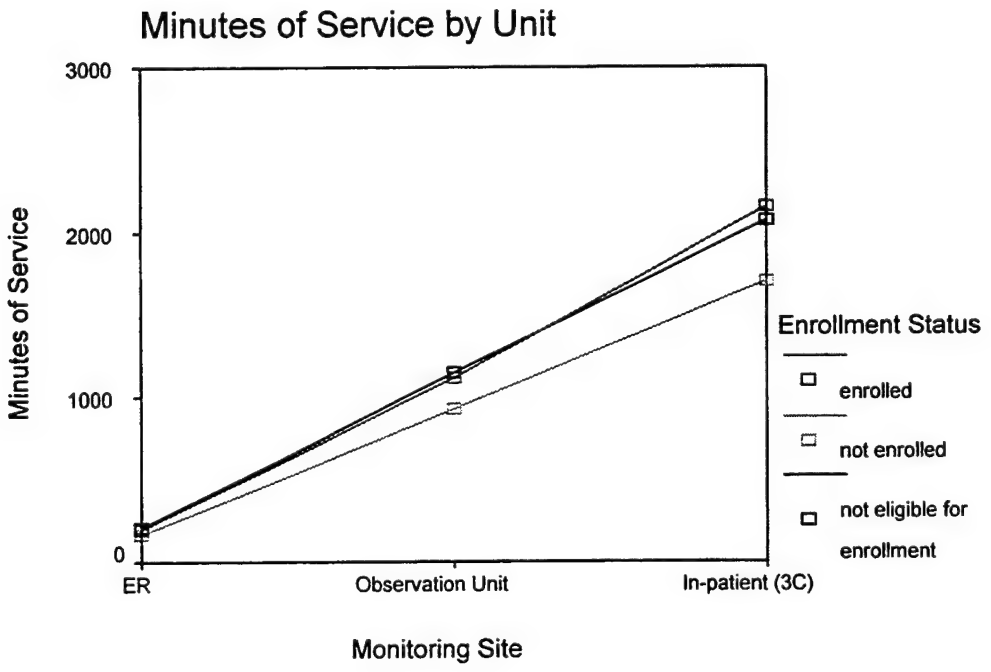

Figure 2. Length of Stay and TRICARE Enrollment Status Among the Monitoring Sites

Retired military members, and their family members, over the age of 65 are not usually eligible for enrollment in TRICARE, however, they are eligible for care in a military MTF. The study site was participating in a pilot program to enroll a limited number of retired military members and/or their family members over 65 years of age in TRICARE Senior Prime. Those members over 65 years of age who were not enrolled in the TRICARE Senior Prime pilot study,

were designated as not eligible for enrollment in TRICARE, but were still eligible for care in the MTF. A one-way ANOVA was used to determine whether those patients who were not eligible for enrollment in TRICARE were over 65 years of age (see Table 29).

Table 29

Mean Patient Age Based on TRICARE Enrollment Status

	TRICARE ENROLLMENT STATUS		
	Enrolled	**Not Enrolled**	**Not Eligible for Enrollment**
MEAN PATIENT AGE (yr.)	61 yr.	50 yr.	72 yr.
Standard Deviation	± 12	± 9	± 11

The patients that were not eligible for enrollment in TRICARE were over 65 years of age. Post-hoc analysis with Tukey's HSD revealed that there were significant differences in mean patient age based on TRICARE enrollment status (F=15.560, df=2, p=.000).

Question 7

Question #7, what are the differences in the demographic characteristics and co-morbidities of patients diagnosed with MI and patients ruled-out for MI among the monitoring sites, could not be answered because only 1.2% (N=2) of the patients were diagnosed with MI.

However, Chi-square analysis was used to determine differences in the number of co-morbidities that increased the risk of heart disease/MI among the patients in the three monitoring sites. The co-morbidities that may increase the risk of heart disease/MI included: (a) diabetes, (b) congestive heart failure, (c) previous MI, (d) hypertension, (e) hypercholesterolemia, and (f) coronary artery disease. Analysis showed that patients with no "heart risk" co-morbidities were more often monitored in the ED (47%, n=26). Patients with only 1 "heart risk" co-morbidity were fairly evenly distributed between the ED (31%, n=17) and the outpatient observation (23%, n=13) monitoring sites. Patients with 2 "heart risk" co-morbidities were primarily monitored in the outpatient observation unit (36%, n=20). And, for patients with 3 or more "heart risk" co-morbidities the inpatient cardiology unit was the preferred monitoring site

(44%, n=22). These results were significant (χ^2= 37.229, *df*=10, *p*=.000). Analysis results are shown in Table 30.

Table 30

Preferred Monitoring Site in Relation to Number of "Heart Risk" Co-morbidities

	MONITORING SITE			
Number of Heart Risk Co-morbidities	**ED**	**Outpatient Observation**	**Inpatient Cardiology**	**Total**
Heart Risk = 0	26	14	7	47
%	45%	24%	13%	28%
Heart Risk =1	17	13	7	37
%	29%	23%	13%	22%
Heart Risk = 2	5	20	14	39
%	9%	35%	27%	24%
Heart Risk =3	4	7	13	24
%	7%	12%	25%	14%
Heart Risk = 4	3	1	6	10
%	5%	2%	12%	6%
Heart Risk =5	0	1	3	4
%	0%	2%	6%	2%
Co-morbidities other than *heart risk*	3	1	2	6
	5%	2%	4%	4%
Total # Patients per Monitoring Site	58	57	52	167
	100%	100%	100%	100%

Chi-square analysis was further used to evaluate differences in patient's in-hospital placement based on number of co-morbidities and physician specialty (for the initial ED evaluation of chest pain). The chi-square analysis was run twice; first using total co-morbidities and, second using only the "heart risk" co-morbidities. Analysis showed that the differences were not significant (χ^2 = 8.777, *df*=6, *p*=.187 [internal medicine specialty]; χ^2 = 8.032, *df*=5, *p*=.154 [cardiology specialty]), however, there was a trend. For the internal medicine specialty, patient placement on the outpatient observation unit or the inpatient cardiology unit based on total number of co-morbidities was random (see Table 31). For the cardiology specialty, patients with less than 2 co-morbidities (73%, n=11) tended to be placed in the outpatient observation unit. Patients with 3 or more co-morbidities (68%, n=20) were placed in the inpatient cardiology unit.

Table 31

Patient Placement by Number of Co-morbidities and Physician Specialty for the Outpatient Observation Unit and the Inpatient Cardiology Unit

Physician Specialty		MONITORING SITE	
		Outpatient Observation Unit	Inpatient Cardiology Unit
Internal Medicine			
	Total Co-morbidities =0	12 (21%)	5 (10%)
	Total Co-morbidities =1	0 (0%)	1 (2%)
	Total Co-morbidities =2	10 (18%)	5 (10%)
	Total Co-morbidities =3	1 (2%)	3 (5%)
	Total Co-morbidities =4	4 (7%)	1 (2%)
	Total Co-morbidities =5	1 (2%)	2 (4%)
	Total Co-morbidities =6	0 (0%)	2 (4%)
	Total Co-morbidities =8	0 (0%)	1 (2%)
Cardiology			
	Total Co-morbidities = 0	14 (24%)	3 (5%)
	Total Co-morbidities =1	3 (5%)	4 (8%)
	Total Co-morbidities =2	8 (14%)	5 (10%)
	Total Co-morbidities =3	1 (2%)	6 (11%)
	Total Co-morbidities =4	1 (2%)	5 (10%)
	Total Co-morbidities =5	2 (3%)	8 (15%)
	Total Co-morbidities =6	0 (0%)	1 (2%)

Analysis of "heart risk" co-morbidities and physician specialty was also not significant (χ^2 = 6.001, *df*=5, p=.306 [internal medicine]; χ^2= 4.972, *df*=4, *p*=.290 [cardiology]). A trend, however, was evident. The internal medicine specialty tended to place patients with 3 or fewer "heart risk" co-morbidities on the outpatient observation unit. Conversely, the cardiology specialty tended to place patients with 2 or more "heart risk" co-morbidities on the inpatient cardiology unit. The study site did not use clinical pathways or protocols in the ED to guide the placement of patients with chest pain.

Chi-square analysis revealed that the distribution of male and female patients was significantly different among the monitoring sites: ED (males, n=23, females, n=35); outpatient observation unit (males, n=31, females, n=26); and, inpatient cardiology unit (males, n=36, females, n=16). Therefore, gender was further analyzed to determine if there were any

differences in the number of "heart risk" co-morbidities between males and females among the monitoring sites. Chi-square analysis showed significant differences in the number of "heart risk" co-morbidities between males (χ^2=15.559, *df*=8, *p* =.049) and females (χ^2=16.887, *df*=8, *p*=.031) among the monitoring sites (see Table 32). Chi-square analysis was further used to analyze differences in the number of co-morbidities between the genders within the ED, since this monitoring site had a larger percentage of female patients treated and released than the other monitoring sites. Analysis showed no significant differences in co-morbidities between males and females (χ^2=1.259, *df*=3, *p*=.739) within the ED (see Table 32). Chi-square analysis was also used to determine if there were any differences in the BMIs between males and females in the ED. Analysis showed no significant differences between males and females with a BMI over 35kg/cm² (χ^2=.772, *df*=1, *p*=.380) or a BMI of 30kg/cm² (χ^2=3.071, *df*=1, *p*=.080)(see Table 33).

Table 32

Differences in Number of Co-morbidities Between Males and Females for Each Monitoring Site

		MONITORING SITE		
Gender	**Number of Heart Risk Co-morbidities**	**ED**	**Outpatient Observation Unit**	**Inpatient Cardiology Unit**
Male	0	8 (14%)	8 (14%)	3 (6%)
	1	8 (14%)	8 (14%)	7 (13%)
	2	2 (3%)	10 (17%)	8 (15%)
	3+	5 (9%)	5 (9%)	18 (34%)
Female	0	20 (34%)	6 (11%)	4 (8%)
	1	9 (16%)	5 (9%)	0 (0%)
	2	3 (5%)	10 (17%)	6 (12%)
	3+	3 (5%)	5 (9%)	6 (12%)

Table 33

Differences in BMI Between Males and Females in the ED

BMI	Gender	Monitoring Site = ED
Obese (>35kg/cm²)	Male	15% (n=3)
	Female	7% (n=2)
Overweight (30kg/cm²)	Male	55% (n=11)
	Female	30% (n=8)

Chapter Summary

This chapter analyzed the demographic characteristics of patients with chest pain. The sample consisted of 167 patients who were monitored in the ED (n=58), outpatient observation unit (n=57) or inpatient cardiology unit (n=52). Statistical analysis revealed that there were no significant differences in the demographic characteristics of age or race among the monitoring sites. Chi-square analysis revealed significant differences in the demographic characteristics of gender and TRICARE enrollment status. There were no significant differences in BMI (a) among the monitoring sites, (b) between males and females, and (c) between males and females in the ED.

This chapter analyzed the study data related to the seven research questions regarding alternative monitoring sites for patients with chest pain. There were significant results for length of stay and costs (nursing staff and costs per length of stay, diagnostic testing, and consultant). There were no significant results for recidivism rate for patients with chest pain. Only 2.6% (N=1) of the patients who returned within 30 days of release from the MTF experienced an MI. Length of stay was not significantly different based on TRICARE enrollment status. There were, however, significant differences in mean patient age based on TRICARE enrollment status. The difference in percent of patients who were ultimately diagnosed with an MI could not be answered; only 1.2% (N=2) of the patients were diagnosed with MIs and were monitored on the inpatient cardiology unit. Further analysis of differences in primary discharge diagnosis among the monitoring sites, however, revealed significant results; 53% (n=31) of the patients monitored

in and released from the ED had a diagnosis of cardiac chest pain, while 97% (n=55) of the patients monitored in and released from the outpatient observation unit had a diagnosis of non-cardiac chest pain.

Differences in physician specialty and type and number of diagnostic tests ordered to rule-out MI among the three monitoring could not be answered. However, analysis of differences in the number and type of diagnostic tests among the units revealed significant results. Differences in demographic characteristics and co-morbidities in patients diagnosed with an MI and ruled-out for an MI also could not be answered because only 1.2% (N=2) of the patients were diagnosed with MI. Alternative analysis of differences in co-morbidities considered to increase risk of heart disease/MI among the monitoring sites revealed significant results. Analysis of differences in number of co-morbidities and physician specialty for the in-hospital monitoring sites (outpatient observation and inpatient cardiology) revealed no significant results, but did indicate a trend toward more conservative placement of patients by physicians whose specialty was cardiology. Chapter V presents the discussion of these findings and recommendations from this study.

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to investigate the costs and patient outcomes, of actual diagnosis of MI and recidivism rate, of three alternatives for monitoring patients with chest pain. This study also examined differences in: (a) Diagnostic testing by physician specialty, (b) co-morbidities and demographic characteristics between patients who were diagnosed with MI and ruled-out for MI, and (c) TRICARE enrollment status and length of stay, among the three alternative sites for monitoring patients with chest pain.

The framework for this study was a cost analysis as described by Reynolds and Gaspari (1985). The study sample was drawn from records of patients who were discharged between November 1, 1998 and April 30, 1999. The sampling period was divided into four 6-week segments with approximately one-quarter of the records selected from each 6-week segment for each monitoring site. This sampling method was intended to control for any potential bias since the study site was a teaching facility where resident physicians rotated to a new clinical service every 6 weeks.

The CEIS database was used to collect the following data: (a) Discharge diagnosis, (b) site of care, (c) date of birth, (d) TRICARE enrollment status, (e) return visits within 30 days of release, (f) and return visit as inpatient admission. The following data were collected from inpatient, observation, and outpatient hospital records: (a) Date and time of arrival to and release from monitoring site; (b) date and time of arrival in ED (for inpatient and observation patients only); (c) gender, height, weight, and race; (d) types of co-morbidities; (e) physician specialty for initial ED evaluation; (f) consultation; (g) continuous telemetry monitoring; and, (h) number of chest x-ray, electrocardiogram, stress test, cardiac catheterization, and echocardiogram tests. The CHCS database was used to collect data on the number and type of laboratory tests performed on each patient. CHCS was also used to collect the results of the CK-MB and Troponin I tests performed on each patient in the study.

The Reynolds and Gaspari (1985) framework recommended that only those costs that vary among the alternatives be studied. An analysis of both recurrent and capital costs revealed that the costs pertinent to this study included: (a) Nursing personnel salaries and fringe benefits, (b) diagnostic testing, (c) consultant fees, and (d) length of stay. The actual number of nursing staff working during each 6-week sampling period in each monitoring site was determined through reviewing monthly duty schedules from November 1, 1998 through April 30, 1999. Chi-square analysis revealed no significant differences in the distribution of RNs, UAPs, and administrative personnel among the 6-week sampling periods within each monitoring site. Therefore, cost analysis compared differences among the monitoring sites only.

Daily nursing salary costs and nursing salary costs per minute of service (MOS) were determined from the monthly salary figures in the MEPRS Grade/Salary Table for the actual number of staff working in each monitoring site. The average cost per MOS for nursing care was determined for each monitoring site. The average cost per MOS for nursing care was multiplied by each patient's length of stay (in minutes) to determine the average cost of nursing care per patient.

Fiscal year 1999 IMET laboratory, radiology, and cardiology procedure rates, and outpatient visit rates for cardiology and internal medicine clinics, issued by the Office of the Under Secretary of Defense (1998), were used as the basis for diagnostic testing and consultant costs in this study.

The total cost of chest pain care for each monitoring site (sum total of each patient's nursing care costs, diagnostic testing costs, continuous telemetry monitoring costs, and consultant costs) was divided by the total number of patients monitored in that site to determine the average cost of chest pain care per patient for each monitoring site.

The study sample consisted of 167 patients who were monitored for chest pain in one of three monitoring sites: ED (N=58), outpatient observation unit (N=57), and inpatient cardiology unit (N=52). Race was analyzed for 92% (N=153) of the study sample of 167 patients. The

patients were primarily Caucasian, 73% (N=111). There were 9% (N=14) African-American, 17% (N=26) Hispanic, and 1% (N=2) Asian American subjects.

Chi-square and multivariate analysis revealed no significant differences in demographic data (gender, race, TRICARE enrollment status, age, height, weight) among the 6-week sampling periods within each monitoring site. Therefore, statistical analyses to answer the study research questions compared differences among the monitoring sites only.

There were no significant differences in the mean ages of the patients among the monitoring sites: ED (*M*=62 yr), outpatient observation (*M*=59 yr), inpatient cardiology unit (*M*=65 yr). Height and weight data were expressed as body mass index (BMI) for overweight (30kg/cm²) and obese (>35kg/cm²) patients. Height and/or weight data were not documented in the records of 31% (N=52) of the patients therefore, BMIs were only calculated for 69% (N=115) of the study sample of 167 patients. Analyses of the differences in BMI showed no significant differences in the number of overweight patients and obese patients among the monitoring sites. BMI analyses also showed no significant differences between males and females population for the number of overweight and obese patients.

The ED had significantly more female patients (21%, n=35) than either of the other monitoring sites (outpatient observation unit 16%, n=26; inpatient cardiology unit 10%, n=16). Differences in TRICARE enrollment status were statistically significant (χ^2=9.998., *df*=4, *p*=.040) with a trend toward more patients that were not eligible for enrollment residing in the inpatient cardiology unit (8%, n=12).

Research question #1 inquired whether there were differences in the length of stay among the monitoring sites. The mean length of stay within each monitoring site was: ED = 197 min (3 hrs. 17 min.); outpatient observation unit = 1,110 min (18 hrs. 20 min.); inpatient cardiology unit = 2,289 min (38 hrs. 9 min.). An ANOVA showed significant differences in length of stay among all three monitoring sites (*F*=81.538, *df*=2, *p*=.000). ANOVA was also used to determine whether there were any differences in the length of stay in the ED for patients who were placed

in the outpatient observation unit (257 min [4 hr 17 min]) and the inpatient cardiology unit (470 min [7 hr 50 min]). Analysis revealed no significant differences in the ED length of stay for patients who were placed in either the outpatient observation or inpatient cardiology units .

Research question #2 inquired whether there were differences in costs (nursing staff, diagnostic testing, consultant, and length of stay) among the monitoring sites. The Reynolds and Gaspari (1985) cost analysis framework was used to determine absolute and relative differences in costs. The inpatient cardiology unit had the lowest average cost per MOS for nursing care ($0.0856). The average cost per MOS ($0.0877) in the outpatient observation unit was 2% greater, and the average cost per MOS ($0.0949) in the ED was 11% greater than the inpatient cardiology unit's cost.

The ED had the lowest average cost per patient (CPP) for monitoring patients with chest pain ($63). Time spent in the ED was a factor in determining the average CPP for patients placed in either the outpatient observation or inpatient cardiology monitoring sites. In the outpatient observation unit the average CPP, including time spent in the ED, was $400. Excluding time spent in the ED, the average CPP in the outpatient observation unit was $364. In the inpatient cardiology unit the average CPP, including time spent in the ED, was $864. Excluding time spent in the ED, the average CPP in the inpatient cardiology unit was $826. The average CPP in both the outpatient observation and inpatient cardiology monitoring sites was more than 450% greater than the average CPP in the ED. The average CPP in the inpatient cardiology unit (including time spent in the ED) was 116% greater than the average CPP in the outpatient observation unit. Length of stay was considered to be a factor in the cost differences among the units.

Research question #3 inquired whether there were differences in the percent of patients diagnosed with MI among the monitoring sites. This question could not be answered because only 1.2% (N=2) of the patients were diagnosed with MI; both of these patients were monitored in the inpatient cardiology unit. Chi-square analysis was used, however, to analyze differences

in patients' primary discharge diagnoses (cardiac chest pain or non-cardiac chest pain) among the monitoring sites. Primary discharge diagnoses among the monitoring sites were: (a) ED, 53% (n=31) cardiac chest pain, 47% (n=27) non-cardiac chest pain; (b) outpatient observation unit, 4% (n=2) cardiac chest pain, 96% (n=55) non-cardiac chest pain; and, (c) inpatient cardiology unit, 36% (n=19) cardiac chest pain, 64% (n=33) non-cardiac chest pain. For the whole sample of 167 patients the primary discharge diagnoses were: (a) cardiac chest pain = 31% (N=52), (b) non-cardiac chest pain = 69% (N=115). Analysis showed significant differences among the monitoring sites for primary discharge diagnoses (χ^2 = 34.464, *df*=2, *p*=.000).

Research question #4 inquired whether there were differences in the 30-day recidivism rate for return to the MTF for the complaint of chest pain among the monitoring sites. Chi-square analysis showed no significant differences in recidivism rates for chest pain among the monitoring sites. Only 1 patient was diagnosed with an MI on return visit; this patient had originally been monitored in the ED.

Research question #5 inquired whether there were differences in the number and type of diagnostic tests ordered to rule-out MI by physician specialty among the three monitoring sites. Physician specialty only varied on initial evaluation in the ED. For the 58 patients monitored in and released from the ED, 97% (n=55) were seen by ED physicians only. Patients who were monitored on the outpatient observation or inpatient cardiology units were initially evaluated in the ED by either an internal medicine or cardiology resident depending on time of day and day of the week. Once these patients were placed on one of the two units, they were followed exclusively by the cardiology service. Therefore, only differences in the number of diagnostic tests among the monitoring sites were analyzed using Chi-square analysis. Significant differences in the number of diagnostic tests were noted among the monitoring sites (χ^2=188.950, *df*=42, *p*=.000), with 49% (n=27) of the patients in the ED having only 2 diagnostic

tests, while 44% (n=22) of the patients in the inpatient cardiology unit had between 13 to 16 tests. Patients on the outpatient observation unit had an average of 11 tests performed.

Chi-square analysis was used to determine whether there were significant differences in the number and type of diagnostic tests between the outpatient observation and inpatient cardiology units. Analysis showed significantly more chest x-rays (χ^2=12.226, *df*=1, *p*=.000), cardiac catheterizations (χ^2=12.226, *df*=1, *p*=.000), echocardiograms (χ^2=12.591, *df*=1, *p*=.000), and complete blood counts (χ^2=25.058, *df*=5, *p*=.000) were conducted on the inpatient cardiology unit. Three or more electrocardiograms (χ^2=13.963, *df*=5, *p*=.016) per patient and two or more comprehensive chemistry panels (CHEM10) per patient were conducted more often on the inpatient cardiology unit (χ^2=19.379, *df*=6, *p*=.004). Significantly more stress tests were conducted on the outpatient observation unit (χ^2=11.115, *df*=1, *p*=.001). There were no significant differences in the number of the following laboratory tests between the two units: CK-MB, Troponin I, CHEM7, PT/PTT, LFT, LDH, lipid panel, ABG, amylase, and lipase. Continuous telemetry monitoring was constant between the outpatient observation and inpatient cardiology units.

Research question #6 inquired whether there were differences in length of stay for patients enrolled in TRICARE and not enrolled in TRICARE among the monitoring sites. Two-way ANOVA, with post-hoc analysis using Tukey's HSD, showed that there was no interaction between monitoring site and enrollment status in relation to length of stay (p=.964). There was a trend, however, toward a longer length of stay for patients not eligible for TRICARE enrollment within all three monitoring sites.

One-way ANOVA was conducted to determine whether the patients that were not eligible for enrollment were over 65 years of age. Retired military members, and their family members, over age 65 are not usually eligible for enrollment in TRICARE, however they are eligible for care in military MTFs. The study site was participating in a pilot program to enroll a limited number of

retired military members and/or their family members over 65 years of age in TRICARE Senior Prime. Those members over 65 years of age not enrolled in the TRICARE Senior Prime pilot study, were designated as not eligible for enrollment in TRICARE, but were still eligible for care in the MTF. Analysis revealed significant differences (F=15.560, df=2, p=.000) in mean age among patients enrolled (M=61 yr), not enrolled (M=50 yr), and not eligible for enrollment (M=72 yr) in TRICARE. The patients that were not eligible for enrollment in TRICARE were over 65 years of age.

Research question #7 inquired whether there were differences in the demographic characteristics and co-morbidities of patients diagnosed with MI and patients ruled-out for MI among the monitoring sites. Since only 1.2% (N=2) of the patients were diagnosed with MI, this question could not be answered. Chi-square analysis showed significant differences in the number of "heart risk" co-morbidities among the units (χ^2=37.229, df=10, p=.000).

Chi-square analysis revealed no significant differences in placement in the outpatient observation or inpatient cardiology units based on the number of "heart risk" co-morbidities and physician specialty (internal medicine or cardiology) for initial ED evaluation of chest pain. A trend was noted, however, with the cardiology specialty placing patients with 2 or more "heart risk" co-morbidities in the inpatient cardiology unit, while the internal medicine specialty placed patients with 3 or fewer "heart risk" co-morbidities in the outpatient observation unit.

Since the distribution of male and female patients was significantly different among the monitoring sites, Chi-square analysis was used to determine if there were significant differences in the "heart risk" co-morbidities and BMI between males and females. Analysis revealed significant differences in the number of "heart risk" co-morbidities between males (χ^2=15.559, df=8, p=.049) and females (χ^2=16.887, df=8, p=.031) among the monitoring sites. Analysis of "heart risk" co-morbidities between males and females within the ED only revealed no

significant differences. Males and females within the ED also were not significantly different based on BMI for obese patients and overweight patients.

Discussion

Analysis of the demographic characteristics of the patients in this study revealed that 73% (N=111) were Caucasian. This finding was not unexpected as it is consistent with military demographics. The Air Force Personnel Center (2000) active military service demographics reveal that 75% of the active force are Caucasian, 16% are African American, 5% are Hispanic, and 5% are "Other". The mean ages of the patients and the greater percentage of males in this study were consistent with previous studies (DeLeon et al., 1989; Gaspoz et al.; Gibler et al.; Lee et al., 1987; Lee et al., 1991; McGough, 1997; and Mikhail et al., 1997).

An unexpected, and significant, finding was the distribution of female patients among the monitoring sites. A greater percentage of female patients were monitored in and released from the ED. However, the risk factors for MI ("heart risk" co-morbidities, and overweight and obese BMI) between the male and female patients within the ED were not significantly different. This finding warrants further study to investigate potential gender bias in chest pain evaluation in the ED. Lehmann, Wehner, Lehmann, and Savory (1996), studied gender bias in ED chest pain evaluation. The authors found that, although there were no significant differences in their risk factors for MI, men were treated more aggressively than women. Women in their study were significantly more likely to receive controlled substances and anxiolytics, suggesting that the women's complaints of chest pain were being 'dismissed' as psychiatric or psychosomatic. The authors warned that extreme caution should be taken in this approach to ruling-out MI in women who present with complaints of chest pain, because studies "on myocardial infarction that involve women indicate a higher incidence of 'atypical' symptoms" (p.643).

Significantly more patients who were not eligible for enrollment in TRICARE were monitored in the inpatient cardiology unit (8%, n=12) when compared with the ED and the outpatient observation unit (3%, n=4). Since patients that were not eligible for enrollment in TRICARE

were over age 65 (*M*=70 yr), it is not unexpected that the inpatient cardiology unit would be used more often to monitor these patients.

This study found significant differences in the length of stay among the three monitoring sites. From the review of the literature this was not unexpected. Normal ED operations allow only 1 to 2 hours to make disposition decisions (admission or discharge home) (Graff, Mucci, & Radford, 1988). Inpatient services are for patients who require large amounts of nursing services per patient for prolonged periods of time. Outpatient observation services provide intensity of service equivalent to inpatient units, but for a limited duration of time, usually not exceeding 24 hours (Graff, 1993).

This study also found significant differences in costs among the three monitoring sites. The ED had the lowest average CPP. This finding supports other study findings that length of stay is the greatest determinant in cost even if other cost factors are higher (DeLeon et al., 1989; Graff,1993; Miller, 1999; and Zun,1990). The average CPP in the outpatient observation monitoring site was significantly lower than the average CPP in the inpatient cardiology unit. This finding also supports other findings reported in the review of the literature that length of stay is a significant cost factor.

In this study, 1.2% (N=2) of the patients were diagnosed with MI and both of these patients were monitored in the inpatient cardiology unit. This finding is much lower than a previous finding by DeLeon et al. (1989) where 18% of patients with chest pain admitted to an inpatient unit were diagnosed with MI. The low rate of MI diagnoses in this study may be explained by subsequent findings of significant differences in the percent of cardiac chest pain and non-cardiac chest pain diagnoses among the monitoring sites. On the inpatient cardiology unit, only 36% (n=19) of the patients had a discharge diagnosis of cardiac chest pain, while the majority, 64% (n=33), had a diagnosis of non-cardiac chest pain. On the outpatient observation unit 96% (n=55) of the patients had a discharge diagnosis of non-cardiac chest pain, while only 4% (n=2) had a discharge diagnosis of cardiac chest pain. These findings were consistent with other

study findings that the majority of patients evaluated for chest pain had a non-cardiac cause for their pain (Cardiology Preeminence Roundtable, 1997; Gomez et al., 1996; and Weingarten et al., 1994). A confounding finding in this study was the distribution of cardiac chest pain, 53% (n=31), and non-cardiac chest pain, 47% (n=27), discharge diagnoses within the ED monitoring site. This finding was not expected; previous studies have found that the majority of patients evaluated for chest pain had a non-cardiac cause for their pain (Cardiology Preeminence Roundtable, Gomez et al., and Weingarten et al.). This finding warrants further study.

The findings of this study showed no significant differences in the 30-day recidivism rates for chest pain among the monitoring sites. Among the patients who returned within 30 days (23%, N=38), only 2.6% (N=1) were subsequently diagnosed with an MI; this patient had been originally monitored in the ED. This finding was not unexpected; previous studies have found that only 1 to 2 patients who returned within 30 days with complaints of chest pain were diagnosed with MI (DeLeon et al., 1989; Gibler et al., 1995).

This researcher was unable to test variability in diagnostic testing by physician specialty because physician specialty only varied on initial evaluation in the ED. In the ED, 97% of the patients saw only ED physicians, while patients placed in the outpatient observation or inpatient cardiology units were initially evaluated by either an internal medicine or cardiology resident depending on time of day and day of week. Analysis did reveal variability in diagnostic testing among the monitoring sites with patients in the ED having the least number of tests performed, while patients on the inpatient cardiology unit had the most tests performed. This finding was expected. Further analysis revealed some variability in the number and type of diagnostic tests performed in the outpatient observation and inpatient cardiology units. Although these findings only included a comparison of diagnostic testing between units and did not include the physician specialty variable, there are similarities to findings by Gomez et al. (1996) that patients with chest pain on inpatient units undergo more expensive testing more frequently than patients in alternative monitoring sites.

The ED used an operating instruction to direct the initial management of patients with chest pain. A rule-out MI protocol was used in the outpatient observation unit for patients with chest pain; this protocol guided the number and type of diagnostic tests performed. The inpatient cardiology unit did not use a protocol to direct diagnostic testing in patients with chest pain and study results revealed that this unit had a significantly higher number of diagnostic tests conducted and significantly higher diagnostic testing costs. From the review of literature, the use of protocols to rule-out MI in patients with chest pain is widely encouraged (Finefrock, 1994; Gibler et al., 1995; Gomez et al., 1996; Graff, 1993; and, Zalenski et al., 1997). From the researcher's perspective, the use of protocols would reduce costs in caring for patients with chest pain.

Although there were significant differences in the number of other diagnostic tests conducted among the monitoring sites, there were no significant differences in the number of CK-MB and Troponin-I (cardiac enzyme) tests conducted between the outpatient observation unit and the inpatient cardiology unit and no significant differences in patient outcomes (MI diagnosis, recidivism rates for chest pain) between the two units. Research has identified cardiac enzyme test results as the primary method to rule out MI in patients with chest pain (DeLeon et al., 1989; Gaspoz et al., 1994, Gibler et al., 1995, Graff, 1993, and Lee et al., 1991). These study results demonstrate that the outpatient observation unit is equally as effective in ruling out MI in patients with chest pain as the inpatient cardiology unit, and at lower cost.

This study found no significant differences between TRICARE enrollment status and length of stay among the alternatives for monitoring patients with chest pain. There was, however, a trend toward longer length of stay for patients who were not eligible for enrollment in TRICARE in each of the three monitoring sites. Further analysis revealed significant differences in mean age among patients who were enrolled (M=61 yr), not enrolled (M=50 yr), and not eligible for enrollment (M=72 yr) in TRICARE. Patients over age 65 are not eligible for enrollment in TRICARE. At this study site, TRICARE Senior Prime was being pilot tested and a limited

number of patients over age 65 were eligible for enrollment in TRICARE Senior Prime. Those patients over age 65 who were not enrolled in TRICARE Senior Prime were designated as not eligible for enrollment in TRICARE, however, they were eligible for care in a military MTF. Therefore, in this study, the patients who were not eligible for enrollment in TRICARE were patients over age 65, who were not enrolled in the TRICARE Senior Prime pilot test, but were eligible for care in a military MTF. This patient population would be expected to have longer length of stay, therefore, this finding was not unexpected.

This researcher was unable to test differences in demographic characteristics and co-morbidities between patients diagnosed with MI and patients ruled-out for MI because only 1.2% (n=2) patients were diagnosed with MI. Significant differences were found, however, in the number and type of co-morbidities among the monitoring sites suggesting that higher-risk or higher acuity patients were monitored in the inpatient cardiology unit. This was not an unexpected finding and supports previous studies that recommend the use of alternative monitoring sites only for patients at low-risk for developing MI (Fineberg et al., 1984; Gaspoz et al., 1991; Gibler et al., 1995; Gomez et al., 1996; and Toteson et al., 1996).

Implications

This study demonstrated that all three alternatives for monitoring patients with chest pain provided safe care. The research literature is replete with studies that report the cost-effectiveness of ED observation units. Only one study, however, examined the cost-effectiveness of chest pain care provided in a non-ED observation delivery site (DeLeon et al., 1989). This study reaffirms the findings of DeLeon et al. regarding the cost-effectiveness of outpatient observation units. This study provides evidence that, for patients at risk for an MI, an outpatient observation unit is safe, costs less, and has patient outcomes similar to inpatient monitoring sites.

Recommendations for Further Research

Several findings within this study warrant further investigation. First, a greater percentage of female patients were monitored in and released from the ED. The findings of this study did not suggest that the female patients in the sample were less at risk for MI. Do these findings suggest a bias toward males regarding the risk of MI? Lehmann et al. (1996) note that the majority of research regarding coronary artery disease has been male-oriented and has overlooked the magnitude of this disease in women. Overall, the authors concluded that although "coronary artery disease is the number one cause of mortality in women, those with new-onset chest pain who present with similar symptoms as men are approached, diagnosed, and, treated less aggressively than men" (p. 643). Prospective analysis of gender as it relates to the evaluation and disposition of patients with chest pain in the ED is needed.

Second, in this study the fairly equal distribution of patients with cardiac and non-cardiac chest pain in the ED monitoring site was not consistent with other study findings. Instead, other studies have shown that the majority of patients evaluated for chest pain have a non-cardiac cause for their chest pain (Cardiology Preeminence Roundtable, 1997; Gomez et al., 1996; and Weingarten et al., 1994). A prospective study examining the presentation of patients with chest pain and the disposition decision-making process in the ED is needed to further document this phenomenon.

Third, this study revealed a trend in the placement of patients in the outpatient observation or inpatient cardiology units based on their number of co-morbidities and physician specialty. The internal medicine specialty placed patients with three or fewer "heart risk" co-morbidities in the outpatient observation unit, while the cardiology specialty placed patients with two or more "heart risk" co-morbidities in the inpatient cardiology unit. The study site did not use clinical pathways or protocols in the ED to guide the management of patients with chest pain. Approximately $3 billion in public resources are consumed in ruling-out MI in patients with chest pain (Tallon, 1996; Zalenski et al., 1997). The use of clinical pathways/protocols to guide the

management of patients with chest pain is widely encouraged in the research literature (Finefrock, 1994; Gaspoz et al., 1991; Gibler et al., 1995; Gomez et al., 1996; Graff, 1993; Lee et al., 1987; Lee et al., 1991; Wears et al., 1989; and, Zalenski et al., 1997). An opportunity exists for nurses to take a greater role in determining cost-effective alternatives to caring for patients with chest pain. This role may include collaboration in the development of multidisciplinary clinical pathways for the initial and ongoing management of patients with chest pain.

Fourth, the cost to rule-out MI in patients with chest pain was significantly less in the outpatient observation unit than the inpatient cardiology unit. Although co-morbidities differed significantly between these two units, only 1.2% (N=2) of the patients in the study ruled in for MI. Only 2.6% (N=1) of the patients with chest pain returned within 30 days with a diagnosis of MI and this patient was originally monitored in the ED. There were no significant differences in the number of cardiac enzyme tests (CK-MB & Troponin I) used to rule-out MI in patients with chest pain between the two units. Based on these findings, it is suggested that the use of the outpatient observation unit as the primary site for ruling-out MI in patients with chest pain be further studied. The use of the outpatient observation unit as the primary site for ruling-out MI has the potential to significantly reduce the facility's costs of caring for patients with chest pain, while maintaining safe patient outcomes.

Finally, a limitation of this study is that the findings are based on the examination of only one healthcare facility. It is recommended that further research incorporate multiple sites in order to enhance the generalizability of the findings.

APPENDIX A

NURSING STAFF COSTS

Table A1

Nursing Staff, Daily Salary Costs, and Salary Costs per MOS for Each 6-Week Segment of the Sampling Period for the Emergency Department

Unit*	Staff	Monthly Salary	Segment #1**	Daily Salary	Salary/ MOS	Segment #2**	Daily Salary	Salary/ MOS	Segment #3**	Daily Salary	Salary/ MOS	Segment #4**	Daily Salary	Salary/ MOS
1	Major	$7,970	2	$531	$0.37	2	$531	$0.37	2	$531	$0.37	2	$531	$0.37
1	Captain	$6,608	21	$4,626	$3.19	21	$4,626	$3.19	22	$4,846	$3.35	21	$4,626	$3.19
1	Lieutenant	$4,622	11	$1,695	$1.17	13	$2,003	$1.38	13	$2,003	$1.38	14	$2,157	$1.49
1	Lieutenant	$3,636	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
1	Master Sergeant	$4,432	1	$148	$0.10	1	$148	$0.10	1	$148	$0.10	1	$148	$0.10
1	Technical Sergeant	$3,846	4	$513	$0.35	4	$513	$0.35	4	$513	$0.35	4	$513	$0.35
1	Staff Sergeant	$3,348	15	$1,674	$1.16	14	$1,562	$1.08	15	$1,674	$1.16	16	$1,786	$1.23
1	Senior Airman	$2,756	19	$1,745	$1.21	17	$1,562	$1.08	17	$1,562	$1.08	16	$1,470	$1.02
1	Airman 1st Class	$2,242	6	$448	$0.31	8	$598	$0.41	7	$523	$0.36	9	$673	$0.46
1	Airman	$2,061	3	$206	$0.14	1	$69	$0.05	1	$69	$0.05	1	$69	$0.05
1	Airman Basic	$1,752	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
1	Civilian: Medical	$2,902	4	$387	$0.27	4	$387	$0.27	4	$387	$0.27	4	$387	$0.27
1	Civilian: Administrative	$2,322	5	$387	$0.27	5	$387	$0.27	5	$387	$0.27	5	$387	$0.27
Totals			91	$12,360	$8.54	90	$12,385	$8.55	91	$12,642	$8.73	93	$12,745	$8.80
6-Wk Segment Total				$556,204			$557,324			$568,895			$573,530	
Average Costs					$0.0938			$0.0959			$0.0959			$0.0946
Total Salary Costs for the ED = $2,093,969; Average Salary Costs / MOS = $0.0949														
***Unit #1=Emergency Department; Segment #1 = November 1 - December 15, 1998; Segment #2 = December 16, 1998 - January 31, 1999; Segment #3 = February 1 - March 15, 1999; Segment #4 = March 16 - April 30, 1999.**														

APPENDIX A

NURSING STAFF COSTS (cont.)

Table A2

Nursing Staff, Daily Salary Costs, and Salary Costs per MOS for Each 6-Week Segment of the Sampling Period for the Outpatient Observation Unit

Unit*	Staff	Monthly Salary	Segment #1**	Daily Salary	Salary/ MOS	Segment #2**	Daily Salary	Salary/ MOS	Segment #3**	Daily Salary	Salary/ MOS	Segment #4**	Daily Salary	Salary/ MOS
2	Major	$7,970	0	$0	$0.00	0	$0	$0.00	1	$266	$0.18	1	$266	$0.18
2	Captain	$6,608	8	$1,762	$1.22	8	$1,762	$1.22	7	$1,542	$1.06	7	$1,542	$1.06
2	Lieutenant	$4,622	4	$616	$0.43	4	$616	$0.43	3	$462	$0.32	3	$462	$0.32
2	Lieutenant	$3,636	1	$121	$0.08	1	$121	$0.08	2	$242	$0.17	2	$242	$0.17
2	Master Sergeant	$4,432	1	$148	$0.10	1	$148	$0.10	1	$148	$0.10	1	$148	$0.10
2	Technical Sergeant	$3,846	1	$128	$0.09	1	$128	$0.09	1	$128	$0.09	1	$128	$0.09
2	Staff Sergeant	$3,348	1	$112	$0.08	1	$112	$0.08	1	$112	$0.08	1	$112	$0.08
2	Senior Airman	$2,756	11	$1,011	$0.70	10	$919	$0.63	9	$827	$0.57	8	$735	$0.51
2	Airman 1st Class	$2,242	4	$299	$0.21	6	$448	$0.31	6	$448	$0.31	6	$448	$0.31
2	Airman	$2,061	4	$275	$0.10	3	$206	$0.14	2	$137	$0.09	3	$206	$0.14
2	Airman Basic	$1,752	1	$58	$0.04	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
2	Civilian: Medical	$2,902	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
2	Civilian: Administrative	$2,322	1	$77	$0.05	1	$77	$0.05	1	$77	$0.05	1	$77	$0.05
Totals			37	$4,607	$3.18	36	$4,538	$3.13	34	$4,390	$3.03	34	$4,367	$3.02
Six-Wk Segment Total				$207,324			$204,197			$197,535			$196,493	
Average Costs					$0.0860			$0.0871			$0.0892			$0.0887
Total Salary Costs for the Outpatient Observation Unit= $747,707; Average Salary Costs / MOS = $0.0877														
***Unit #2=Outpatient Observation Unit; Segment #1 = November 1 - December 15, 1998; Segment #2 = December 16, 1998 - January 31, 1999; Segment #3 = February 1 - March 15, 1999; Segment #4 = March 16 - April 30, 1999.**														

APPENDIX A

NURSING STAFF COSTS (cont.)

Table A3

Nursing Staff, Daily Salary Costs, and Salary Costs per MOS for Each 6-Week Segment of the Sampling Period for the Inpatient Cardiology Unit

Unit*	Staff	Monthly Salary	Segment #1**	Daily Salary	Salary/ MOS	Segment #2**	Daily Salary	Salary/ MOS	Segment #3**	Daily Salary	Salary/ MOS	Segment #4**	Daily Salary	Salary/ MOS
3	Major	$7,970	2	$531	$0.37	2	$531	$0.37	2	$531	$0.37	2	$531	$0.37
3	Captain	$6,608	3	$661	$0.46	4	$881	$0.61	4	$881	$0.61	4	$881	$0.61
3	Lieutenant	$4,622	8	$1,233	$0.85	4	$616	$0.43	4	$616	$0.43	5	$770	$0.53
3	Lieutenant	$3,636	10	$1,212	$0.84	10	$1,212	$0.84	10	$1,212	$0.84	10	$1,212	$0.84
3	Master Sergeant	$4,432	1	$148	$0.10	1	$148	$0.10	1	$148	$0.10	1	$148	$0.10
3	Technical Sergeant	$3,846	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00	1	$128	$0.09
3	Staff Sergeant	$3,348	3	$335	$0.23	3	$335	$0.23	3	$335	$0.23	2	$223	$0.15
3	Senior Airman	$2,756	3	$276	$0.19	3	$276	$0.19	3	$276	$0.19	2	$184	$0.13
3	Airman 1st Class	$2,242	9	$673	$0.46	11	$822	$0.57	13	$972	$0.67	13	$972	$0.67
3	Airman	$2,061	3	$206	$0.14	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
3	Airman Basic	$1,752	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00	0	$0	$0.00
3	Civilian: Medical	$2,902	1	$97	$0.07	1	$97	$0.07	1	$97	$0.07	1	$97	$0.07
3	Civilian: Administrative	$2,322	1	$77	$0.05	1	$77	$0.05	1	$77	$0.05	1	$77	$0.05
Totals			44	$5,448	$3.76	40	$4,995	$3.45	42	$5,144	$3.55	42	$5,223	$3.61
Six-Wk Segment Total				$245,144			$224,775			$231,501			$235,047	
Average Costs					$0.0855			$0.0862			$0.0846			$0.0859
Total Salary Costs for the Inpatient Cardiology Unit = $869,226; Average Salary Costs / MOS = $0.0856														
***Unit #3=Inpatient Cardiology Unit: Segment #1 = November 1 - December 15, 1998; Segment #2 = December 16, 1998 - January 31, 1999; Segment #3 = February 1 - March 15, 1999; Segment #4 = March 16 - April 30, 1999.**														

References

Air Force Personnel Center (2000). Service demographics. Available: www.afpc.randolph.af.mil/pubaffairs/release/2000/02/demographics.htm (April 9, 2000)

American College of Emergency Physicians Information Paper (1995). Chest pain units in emergency departments--a report from the short-term observation services section. The American Journal of Cardiology, 76, 1036-1039.

Brillman, J., Mathers-Dunbar, L., Graff, L., Joseph, T., Leikin, J. B., Schultz, C., Severance, H. W., & Werne, C. (1995). Management of observation units. Annals of Emergency Medicine, 25 (6), 823-830.

Buppert, C. (1998). HCFA releases final rules on PA and NP medicare reimbursement. Clinical News, 2 (6), 1, 10, & 27-28 [on-line]. Available: http://orthopedics.medscape.com/CPG/ClinNews/1998/v02.n06/cn0206.01.02.html (October 13, 1999).

Cardiology Preeminence Roundtable (1997). Future of outcomes management for cardiac services. Washington, DC: Cardiology Preeminence Roundtable.

Chang, W., & Henry, B. M. (1999). Methodologic principles of cost analyses in the nursing, medical, and health services literature, 1990-1996. Nursing Research, 48 (2), 94-104.

DeLeon, A. C., Farmer, C. A., King, G., Manternach, J. & Ritter, D. (1989). Chest pain evaluation unit: A cost-effective approach for ruling out acute myocardial infarction. Southern Medical Journal, 82 (9), 1083-1089.

Fagin, C. M. & Jacobson, B. S. (1985). Cost-effectiveness analysis in nursing research. Annual Review of Nursing Research, 3, 215-238.

Farrell, R. G. (1982). Use of an observation ward in a community hospital. Annals of Emergency Medicine, 11 (7), 353-356.

Fineberg, H. V., Scadden, D. & Goldman, L. (1984). Care of patients with a low probability of acute myocardial infarction: Cost effectiveness of alternatives to coronary-care-unit admission.

The New England Journal of Medicine, 310 (20), 1301-1306.

Finefrock, S. (1994). Stretching the healthcare dollar: The emergency department observation unit. Journal of Emergency Nursing, 20 (6), 487-490.

Finkler, S. A. (1982). The distinction between cost and charges. Annals of Internal Medicine, 96 (1), 102-109.

Finkler, S. A. & Kovner, C. T. (1993). Financial management for nurse managers and executives. Philadelphia: W. B. Saunders Company.

Gaspoz, J. M., Lee, T. H., Cook, F., Weisberg, M. C., & Goldman, L. (1991). Outcome of patients who were admitted to a new short-stay unit to "rule-out" myocardial infarction. The American Journal of Cardiology, 68 (2), 145-149.

Gibler, W. B., Runyon, J. P., Levy, R. C., Sayre, M. R., Kacich, R., Hattemer, C. R., Hamilton, C., Gerlach, J. W., & Walsh, R. A. (1995). A rapid diagnostic and treatment center for patients with chest pain in the emergency department. Annals of Emergency Medicine, 25, 1-8.

Gomez, M. A., Anderson, J. L., Karagounis, L. A., Muhlestein, J. B., & Mooers, F. B. (1996). An emergency department-based protocol for rapidly ruling out myocardial ischemia reduces hospital time and expense: Results of a randomized study (ROMIO). Journal of the American College of Cardiology, 28 (1), 25-33.

Graff, L. G. (1993). Observation Medicine. Boston: Andover Medical Publishers, Inc.

Graff, L., Mucci, D., & Radford, M. J. (1988). Decision to hospitalize: Objective diagnosis-related group criteria versus clinical judgment. Annals of Emergency Medicine, 17 (9), 943-952.

Health Care Financing Administration (1987). Intermediary manual part 3, chapter II: Coverage of services: section 3112.1 [on-line]. Available: http://www.hcfa.gov/pubforms/13%5Fint/a3106.htm (September 27, 1999).

Health Care Financing Administration (1989). Hospital manual, chapter II: Coverage of hospital services, section 210 [on-line]. Available: http://www.hcfa.gov/pubforms/10_hospital/ho200.htm (October 7, 1999).

Health Care Financing Administration (1997). Highlights national health expenditures, 1997 [on-line]. Available: http://www.hcfa.gov/stats/nhe%2Doact/hilites.htm (October 7, 1999).

Hoekstra, J. W., Gibler, W. B., Levy, R. C., Sayre, M., Naber, W., Chandra, A., Kacich, R., Magorien, R., & Walsh, R. (1994). Emergency department diagnosis of acute myocardial infarction and ischemia: A cost analysis. Academic Emergency Medicine, 1, 103-110.

Kushner, R. F. (1993). Body weight and mortality. Nutrition Reviews, 51 (5), 127-136.

Lee, T. H., Juarez, G., Cook, E. F., Weisberg, M. C., Rouan, G. W., Brand, D. A., & Goldman, L. (1991). Ruling out acute myocardial infarction: A prospective multicenter validation of a 12-hour strategy for patients at low-risk. The New England Journal of Medicine, 324 (18), 1239-1246.

Lee, T. H., Rouan, G. W., Weisberg, M. C., Brand, D. A., Cook, E. F., Acampora, D., Goldman, L., & The Chest Pain Study Group (1987). Sensitivity of routine clinical criteria for diagnosing myocardial infarction within 24 hours of hospitalization. Annals of Internal Medicine, 106 (2), 181-186.

Lehmann, J. B., Wehner, P. S., Lehmann, C. U., & Savory, L. M. (1996). Gender bias in the evaluation of chest pain in the emergency department. The American Journal of Cardiology, 77 , 641-644.

Maag, R., Krivenko, C., Graff, L., Joseph, A., Klopfer, A. H. L., Donofrio, J., D'Andrea, R., & Salamone, M. (1997). Improving chest pain evaluation within a multihospital network by the use of emergency department observation units. The Joint Commission Journal on Quality Improvement, 23 (6), 312-20.

McGough, P. D. (1997). Conservative versus fast track rule out myocardial infarction protocols: A cost and length of stay comparison with low risk chest pain patients in a military hospital. Unpublished master's thesis, Wright State University, Dayton, Ohio.

Microsoft EXCEL™ (1999). Microsoft Office 2000 [Computer software]. Seattle: Microsoft, Inc.

Mikhail, M. G., Smith, F. A., Gray, M, Britton, C., & Frederiksen, S. M. (1997). Cost-effectiveness of mandatory stress testing in chest pain center patients. Annals of Emergency Medicine, 29 (1), 88-97.

Miller, J. (1999, February). Management of a 22-bed monitored adult observation unit. Paper presented at the Observation Medicine '99 Conference, Chicago, IL.

Munro, B. H. (1997). Statistical methods for health care research. Philadelphia: Lippincott.

National Coalition on Health Care (1999). Health care facts: What you need to know [on-line]. Available: http://www.nchc.org/know/spending.html (October 13, 1999).

Office of the Undersecretary of Defense (1998). FY 1999 department of defense (DoD) reimbursable rates. Available: http: www.dtic.mil/comptroller/rates (April 9, 2000).

Reynolds, J. & Gaspari, K. C. (1985). Cost-effectiveness analysis (Monograph series: Methods paper 2). Chevy Chase, MD: Primary Health Care Operations Research.

Silverstein, M. & Ward, D. (1999). What does it cost? Is it worth it? Part 1: Using evidence from economic analyses to guide decision-making. Verdict Brief: VA Center of Excellence Quarterly Newsletter, Summer-Fall, 1-4.

Sox, H. C., Jr. (1979). Quality of patient care by nurse practitioners and physician's assistants: A ten-year perspective. Annals of Internal Medicine, 91 (3), 459-468.

Tallon, R. W. (1996). Chest pain observation units. Nursing Management, 27 (5), 49, 53-54.

Thomas, C. L. (Ed.) (1974). Taber's cyclopedic medical dictionary. Philadelphia: F. A. Davis Company.

Tosteson, A. N. A., Goldman, L., Udvarhelyi, S., & Lee, T. (1996). Cost-effectiveness of a coronary care unit versus an intermediate care unit for emergency department patients with chest pain. Circulation, 94 (2), 143-150.

Wears, R. L., Li, S., Hernandez, J. D., Luten, R. C., & Vukich, D. J. (1989). How many myocardial infarctions should we rule out? Annals of Emergency Medicine, 18 (9), 953-962.

Weingarten, S. R., Riedinger, M. S., Conner, L., Lee, T. H., Hoffman, I., Johnson, B., & Ellrodt, A. G. (1994). Practice guidelines and reminders to reduce duration of hospital stay for patients with chest pain. Annals of Internal Medicine, 120 (4), 257-263.

Wilford Hall Medical Center (59th Medical Wing) Emergency Department Operating Instruction 44-11 (1997). Initial management of chest pain.

Williamson, D. F. (1993). Descriptive epidemiology of body weight and weight change in U.S. adults. Annals of Internal Medicine, 119 (7), 646-649.

Zalenski, R. J., Rydman, R. J., McCarren, M., Roberts, R. R., Jovanovic, B., Das, K., Mensah, E. K., & Kampe, L. M. (1997). Feasibility of a rapid diagnostic protocol for an emergency department chest pain unit. Annals of Emergency Medicine, 29 (1), 99-108.

Zun, L. (1990). Observation units: Boom or bust for emergency medicine. The Journal of Emergency Medicine, 8, 485-490.